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<http://dx.doi.org/doi:10.21954/ou.ro.00004d87>

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**Factors Affecting the Use of Computer Assisted Learning by
Further Education Biology Teachers**

Thesis submitted for the degree of Doctor of Philosophy in Educational
Technology

19th July 1999

The Institute of Educational Technology

The Open University, UK

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DATE OF SUBMISSION: 19 JULY 1999

DATE OF AWARD : 16 DECEMBER 1999

Abstract

The UK educational system is currently under pressure from many quarters to increase its use of educational technology. Within this context, this thesis investigates the nature of a range of factors which influence teachers' use of computer assisted learning (CAL), focusing on biology teachers in Further Education (FE). The factors were identified from the literature, and include aspects such as resourcing, and the teachers' classroom practice and educational philosophies.

There were three main stages to the thesis research. The first stage involved a survey of 68 FE biology teachers. The second stage involved two interviews each with 20 of the survey respondents, producing approximately 80 hours of audiotape. The third stage involved a total of nine classroom observations with six of the interviewees, producing approximately nine hours of videotape and nine hours of audiotape.

The conclusions describe how the factors interacted to affect CAL use amongst the FE biology teachers. The findings stress the importance of teachers' development of classroom familiarity with computers; this development was encouraged by both current and previous exposure to the classroom practice of other computer-using teachers. The teachers involved in the study were generally positive about educational technology, but critical about many currently available biology programs; this critical perspective was particularly evident amongst the more student-centred teachers. The findings outline a list of criteria that the teachers appeared to consider when reviewing programs, and describe the relationship between the use of software and the teachers' classroom practice.

The conclusions outline the potential of a framework developed by Brown and McIntyre (1993) for future studies of how classroom practice affects, and is affected by, educational technology. The conclusions also make recommendations, based on the findings, to those responsible for FE policy and staff development about how they might help to increase teachers' use of CAL.

Acknowledgements

There are many people whose help and support has been invaluable to me during the course of this thesis. First and foremost, I would like to thank my supervisors, Ann Jones and Eileen Scanlon, for being so generous with their time and considerable expertise. I would also like to thank Pat Fung, Karen Littleton, Piers Worth and Erica Morris for reading the first draft of the thesis and providing me with such informed and helpful comments. The administrative support in IET has made the last few years much easier than they might have been, and my thanks for this go to, amongst others, Pauline Adams, Di Mason, Pat Cross and Hansa Solanki.

Erica Morris has shared an office with me for most of our time at the OU, and has been a great friend, as well as a provider of encouragement, tea and advice on all things statistical. Iraklis Paraskakis has also been a great friend, and, along with Dave Perry, a source of technical help. My thanks also go to Piers Worth, Stylianos Hatzipanagos and my other OU friends for making IET such a good place to come to.

Outside the OU, my thanks go to all the FE biology teachers who were involved in the field work, and especially to those who agreed to be observed in their classrooms. Ashley Garner comes in for particular thanks for his extensive involvement.

David Albery, Martin Johnson, Gavin Jones, Alice Samuel and Julie Thompson were all very generous with their time, and I benefited greatly from their enthusiasm, pedagogical expertise, and, in some cases, their day-to-day tolerance of a stressed friend doing a PhD! Lastly, my thanks go to my family, Tom, Pat, Susan, Claire and Stephen, who have always provided me with support and encouragement – I am, as always, very grateful to them.

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Chapter One: Introduction

The research described in this thesis explores the influence of a variety of factors, such as resourcing and individual philosophies about teaching and learning, on teachers' use of computer assisted learning (CAL). The research focuses on Further Education (FE) biology teachers. This chapter introduces the thesis, examining its background, its aims and its structure.

1.1 Background to the thesis

This section consists of three parts. The first outlines the current push towards the increased use of technology which is evident throughout all educational sectors. The second focuses on the impact of this push on FE, and the third outlines the need for further, subject-specific, research in this area.

1.1.1 Technology and education

In July 1998 the Education and Employment Secretary, David Blunkett, commented that

“While information and communications technology has transformed most sectors, our schools - apart from a few cutting-edge examples - remain almost untouched” (Blunkett, 1998, p. 15).

This is despite the fact that

“Significant sums of public and private money have invested in the belief that [IT] has a genuine productive role to play in the education of current and future generations.” (BECTa, 1998a, p.1).

Concerns about the under-utilisation of computer technology in education are common across all educational sectors and many industrialised nations (Davis, 1997). They are

also not new; Richard Hooper noted in 1977 in his review of the National Development Program in Computer Assisted Learning (NDPCAL) that such concerns had already been evident across both sides of the Atlantic for 20 years.

In its bid to bring about the increased use of technology in education the NDPCAL focused to a large extent on teacher development, and Hooper (1977) stressed that it was important for such programs to acknowledge the major influence teachers had on the uptake of educational technology. Recently the focus on teachers has intensified (Davis, 1997). Major government initiatives reflect this, for example in the development of the National Grid for Learning (NGfL), which is described by the Department for Education and Employment (DfEE) as

“a way of finding and using on-line learning and teaching materials, [which will focus] initially on teacher development and the school sector and rapidly extend to lifelong learning [including] further and higher education” (DfEE, 1997, p. 1).

The focus has also been evident in the wide-sweeping government directives to initial teacher training institutions, designed to increase classroom technology use by student and beginner teachers (Passey, 1998).

1.1.2 The specific case of technology and FE

The FE sector has undergone a number of major changes in the last ten years, since it was characterised by Kenneth Baker (1989) as the under funded, low profile “Cinderella” of the education service. The profile of the sector was raised in the government White Paper, *Education and Training for the 21st Century*, (HMSO, 1991) which stressed the significant role FE had to play in government plans to increase the numbers of young people in post-compulsory education and develop a new vocational curriculum. To encourage FE in its new role, the *Further and Higher Education Act*

(HMSO, 1992) removed the sector from local authority control and imposed a new funding regime. This regime was linked to expansion and student achievement, and was controlled by the newly created Further Education Funding Council (FEFC).

The push for increased use of new technology has been clearly evident within FE and a number of recent major policy initiatives have reflected the need to incorporate educational technology throughout the sector's provision (e.g. Dearing, 1996; Kennedy, 1997a; Tomlinson, 1996). Current further education priorities, such as the expansion of student numbers and basic skills training (HMSO, 1998) are heavily reliant on the use of technology (Hughes, 1998) and there is a clear stress on the need to

“improve the availability and quality of learning materials [with the intention of] increasing and widening participation and stimulating demand through new technology” (Kennedy, 1997b, p. 108).

These policy initiatives have been accompanied by considerable expenditure and the sector is currently investing more than £100 million a year in computing equipment (FEFC, 1998). However it was noted in a recent study that although the initiatives had resulted in some “fascinating specialist learning technologies” (Gray and Warrender 1995, p. 12) most of these were applied in centralised resource centres, with very little use being made of such technologies in the classroom as part of the usual teaching programme.

Shortly after the start of this thesis the summary report of the Learning and Technology Committee was published (Higginson, 1996). The Committee was set up by the FEFC and its aims were to investigate the use of technology within FE colleges and to recommend how effective and beneficial use could be increased. Chief amongst

its recommendations was the setting up of a national staff development programme, and specialist advice centres and demonstration projects to show the effective incorporation of learning technologies and the development of learning resources. These recommendations resulted in the Quality in Information and Learning Technology Programme (QUILT) which has now been in operation for two years.

QUILT is guided by a joint advisory committee, which is made up of sector principals and supported by the Further Education Development Agency (FEDA) and the National Council for Educational Technology (NCET)¹. Its overall aims are to:

- support change by individuals and by institutions
- reach 50,000 staff in the FE sector and college governors
- provide a range of activities from awareness raising to skills training (FEDA, 1998).

The first major focus of the QUILT programme has been on staff development (Scribbins, 1997). The need for such a focus was highlighted by a recent National Survey Report (FEFC, 1998a) which found that very few colleges referred specifically to technology in their staff development programmes. The report also stressed that there was, within colleges, insufficient research on the effects of staff development in technology on classroom practice.

This type of research is, however, more evident within schools, where it has been found that staff development programmes in technology often have very limited

¹ now the British Educational Communications and Technology agency, BECTa.

success in bringing about desired increases in the use of educational technology in classrooms (Wild, 1996). Several authors suggest that this is because programmes which are designed to encourage teachers to take up educational innovations are not based on an adequate understanding of the teachers' relationship with that innovation (Doyle & Ponder, 1977; Fullan, 1991; Wild, 1996). It is this relationship that is investigated in this thesis.

1.1.3 The need for further research

Investigations addressing practising teachers' relationships with educational technology are comparatively rare (Willis, 1992). This situation is exacerbated in FE, which is described by Hughes et al (1996) as

“grossly under-researched, studied and analysed” (p. 7).

The concerns expressed by Hughes et al (1996) are not about the total *volume* of research on FE, but about the paucity of *analytical* research.

A recent survey (Johnson, 1997) commissioned by FEDA, adds weight to these concerns. The survey found that there was a considerable amount of research on the sector taking place within FE colleges themselves. Much of this research was stimulated by the need to explore corporate efficiency, and the survey found that most colleges were carrying out market research and research into improving institutional performance or quality. However, less than 20 percent were involved in “basic or strategic” research (Johnson, 1997, p. 8), and support for staff who wished to pursue research degrees was generally accompanied by stipulations that their area of work should be commensurate with the college's objectives. The author concludes that within the sector itself there is

“not enough fundamental or long-term research ... into FE issues” (ibid., p. 9).

Hughes et al (1996) state the case even more strongly following their review of FE research from 1986 to 1996. They suggest that this research had been, in general, either confined to single institutions and primarily descriptive, or on a national scale and consisting of “policy analysis and exhortation” (Hughes et al, 1996, p. 8).

Hughes and her associates (1996) outline four main areas of FE research, namely: policy statements from government departments (e.g. DfEE); evaluation documents from national agencies (e.g. FEFC); reports from support bodies (e.g. FEDA); and books, papers and journal articles from more independent sources. They note that the latter, although rare, provide

“the most independent and analytical source of writing on further education. The other three types, by comparison, are at least as much source documents for analysis as analyses in themselves.” (ibid., p. 8).

However, they also note that these books, papers and journal articles were primarily concerned with policy analyses and case study examinations of individual institutions, therefore adding to a body of research which was

“overwhelmingly reactive, immediate, small-scale, descriptive, insider authored and case study orientated” (ibid., p. 13).

Far more rare were broader accounts of the state of FE and studies focusing on particular issues across a range of institutions. Hughes et al (1996) suggest that there is, overall, a need for

“critical analysis of policy or practice within further education, in the sense of trying to explain and understand these experiences from outside.” (ibid., p. 13).

Such criticisms are not necessarily confined to the FE sector. Willis (1992) for example, notes that there is a need for more doctoral theses which take an analytical

approach to the study of teacher education and information technology. Within his account Willis (1992) specifically mentions the value of research involving qualitative assessments of areas such as the impact of technology on teachers' classroom practice.

Selwynn (1997) is similarly emphatic about the over-reliance in educational technology research on broad surveys and studies which describe, rather than analyse, program implementations. Like Hughes et al (1996), Selwynn (1997) stresses that surveys and descriptive studies have an important role to play, but that there is a need for more research in this area which, firstly, avoids an excessively optimistic tone, secondly, focuses on qualitative methodologies and thirdly, involves more theoretical analysis.

Section 1.1.3 has, so far, described the need for more research on the influence of educational technology on teachers. It has also stressed that such research is particularly needed in the FE sector. The final point to be made in this section is that there is a need for such research to be subject-specific.

In the report from the FEFC on the use of technology in colleges (FEFC, 1998a) it was noted that the practice of using technology in different curriculum areas was very variable. For example, there was extensive use of technology in the construction, engineering and business programme areas, and the art and design and modern language programme areas often had industry-standard, or state-of-the-art computer equipment. In contrast:

“Science departments make little use of technology other than in meeting the requirements of the course and, in the case of GNVQs, developing IT key skills [and] there has been little investment in IT equipment for science” (FEFC, 1998a, p. 9).

These observations suggest that teachers in different curriculum areas may be

working under very different constraints. These constraints are acknowledged in studies which explore the influence of technology on teachers working within specific subject areas. Such studies are, however, far more common in subject areas which have been traditionally associated with CAL, such as physics and mathematics (e.g. DeFreitas Monteiro, 1993), than in subject areas which have not, such as biology.

It is not clear why biology teaching and CAL has been a little studied area, particularly when

“the opportunities to exploit IT in ... teaching are perhaps greater in biology than in physics or chemistry, because there is a wide range of biological phenomena amenable to [IT based] approaches” (Newton, 1997).

The situation may be changing. For example, the influential *Journal of Biological Education*, was relaunched at the end of 1998 with a new emphasis on

“properly researched studies in the use of IT in education.” (Phoenix, 1998).

However, prior to this, the main IT content of the journal concerned program descriptions, and there was little analysis of biology teachers’ use of such programs.

1.2 Aims of the thesis

Within this background the work described in this thesis examines a number of factors which influence FE biology teachers’ use of CAL, using a range of qualitative and quantitative research methods. The main aim of the thesis was to build a fuller picture of the relationship teachers have with educational technology in a relatively under-studied sector (FE) and in a relatively under-studied subject area (biology). The further aims were that this picture should provide some key answers to the following questions:

1. Why do teachers make such little use of educational technology, particularly when

“Educationalists, teachers and pupils all agree that computers benefit ... education”
(Gill, 1996, p.105).

Within this context, what conditions might particularly encourage or discourage teachers’ use of CAL?

2. Which of these conditions could be addressed by those who decide on FE policy and staff development programmes, to help FE teachers make more use of educational technology?
3. Which aspects of CAL do teachers find most interesting and useful? Are these aspects which software developers can consider during the design process?
4. Which methodologies might be fruitful in future examinations of the relationship between teachers and educational technology?

To this end the thesis has three main levels of focus. The first level focuses on the teachers themselves, and the aspects of their work environment that impact on their use of educational technology. The second level focuses on a range of educational software and the attributes which either encourage or discourage use of this software by FE biology teachers. The third level focuses on the interaction between the teachers and the software, and how the experience of this interaction is both affected by and affects classroom practice.

1.3 Outline of the thesis and overview of the research stages

The thesis is structured as follows:

Chapter Two: *Surveys of Teachers using CAL*. This chapter begins with an outline of the range of literature on factors affecting teachers’ use of CAL. It then

describes two sets of large scale studies in this area. The first of these focuses on student teachers, who are just beginning to use computers for teaching, and the second focuses on practising teachers who are experienced users of classroom technology.

Chapter Three: *Studies on the Nature of Classroom Practice*. This chapter begins with a description of studies which view teachers' use of technology within the powerfully-shaping forces of the educational system. It then moves on to review in-depth case studies examining, firstly, teachers' use of classroom technology and secondly, the nature of their general classroom practice. Chapter Three concludes by summarising the factors to be studied in the thesis field work; these factors are represented pictorially as occurring on an 'obstacle course'.

Chapter Four: *Survey of FE Biology Teachers*. This chapter describes the first step in the field work. This involved carrying out a survey of 68 FE biology teachers in order to identify individuals who were prepared to become involved in further research, and explore their use of computers.

Chapter Five: *Methodology*. This chapter describes the methodological grounds for the construction, execution and analysis of the interviews and observations which formed the main part of the thesis field work.

Chapter Six: *Pilot Study*. The research plan outlined in Chapter Five was trialled in a pilot study before being applied to the main study. This chapter describes the two sets of interviews that were carried out with six FE biology teachers, and the observations which were carried out with three of these six. It details the findings and outlines the implications of these for the main study.

Chapter Seven: *Main Study First Interviews*. The main study findings for the first

set of interviews are described in this chapter. These were carried out with a group of 20 FE biology teachers (including the six pilot study interviewees). The findings generally concerned the teachers' resourcing levels and computer-using colleagues, and their thoughts about the nature of teaching, learning and CAL. Chapter Seven reviews the effect these factors had on the teachers' level of CAL use.

Chapter Eight: *Main Study Second Interviews*. This chapter describes the main study findings for the second set of interviews, which were carried out with the same 20 teachers. The interviews explored how a range of specific CAL programs were viewed by the teachers. Chapter Eight examines what made the teachers see a program as potentially useful, and suggests how this might be related both to the attributes inherent in the program and to the teachers' own attributes.

Chapter Nine: *Main Study Classroom Observations*. The main study findings for the observations are described here. These involved classroom observations and interviews with six of the interviewees. Chapter Nine examines the variety of factors affecting the teachers' use of the software.

Chapter Ten: *Conclusions*. This chapter summarises the main findings from the thesis and provides a critical reflection on the research. It describes the findings in terms of their implications for FE policy makers, staff and software development, and further research.

The field work consisted of several stages, with varying numbers of participants. Table 1.1 summarises these.

Table 1.1 Overview of the organisation of the field work

Field work	Number of participants	Comments
Survey of FE biology teachers (<i>Chapter Four</i>)	68	The participants responded to a mailshot which was sent to 65 FE colleges based within an 80 mile radius of London.
Pilot Study (<i>Chapter Six</i>) consisting of:		
First and Second Interviews	6	The six pilot study interviewees were the first of the survey respondents who agreed to be interviewed and observed.
Observations	3	Observations were carried out with three of the six pilot study interviewees.
Main Study First Interviews (<i>Chapter Seven</i>)	20 (i.e. 14 'new' interviewees plus the 6 pilot study interviewees)	The pilot study interviews were re-analysed as part of the main study. Seventeen of the 20 interviewees came from the survey respondent group. Of the other three: one was a colleague of a survey respondent who expressed interest in being involved in the research after the survey had been completed; two were known to the researcher and were included for reasons given in Chapters Six and Seven.
Main Study Second Interviews (<i>Chapter Eight</i>)		
Main Study Observations (<i>Chapter Nine</i>)	6 (i.e. 3 'new' participants and the 3 participants from the pilot study observations)	This was a sub-group of the interviewee group. Three of the six participants were observed once and three were observed twice. The pilot study observations were re-analysed as part of the main study.

1.4 Final notes

The terminology to do with educational technology is constantly in flux. Currently much of the literature on schools refers to ICT (information and computer technology) and much of the literature on FE refers to ILT (information and learning technology). In this thesis the term CAL (computer assisted learning) is used to refer to any computer application that is used to bring about learning.

The research takes a neutral position on the value of educational technology in that it neither assumes, nor investigates, the desirability or otherwise of increasing the use of classroom technology.

Throughout the thesis the term “classroom” is used to refer to the area in which the teacher has timetabled contact with their students. For FE biology teachers this is generally a laboratory and/or classroom.

Chapter Two: Surveys of Teachers using CAL

Chapters Two and Three review literature on teachers' use of CAL. Research into this area often produces very variable findings. Some of this variety seems to relate to the perspective of the researchers or authors and the precise nature of the research. For example, studies which conclude that teachers avoid using computers through technophobia, or fear of losing their status, often seem to be conducted by researchers who have a strong focus on the technology itself, and advocate using this technology in order to change classroom practice (e.g. Chin and Hortin, 1993-94; Hannafin, 1993). By contrast, studies which conclude that the main difficulties in the uptake of technology relate to the nature of classroom practice, and which suggest that the technology needs to be changed to fit in with this practice, often seem to be conducted by researchers who have a strong focus on the nature of the teacher's role (see Section 3.2).

A number of factors other than researcher perspective also influence the findings of such studies. These include, for example, whether

- the research was primarily based on surveys or case-studies
- it focused on teacher characteristics or their educational environments
- the data collected were relatively factual (for example, concentrating on age, gender or teaching experience of the study participants), or aimed to explore participants' perceptions and opinions
- the focus was on non-users, in a bid to find out why they were not using technology, or on extensive users, in a bid to find out how this use had developed.

The main studies which informed the structure of the thesis research were chosen to provide a mixture of these different approaches. However, they all showed a degree of consistency in exploring the issue of teachers' use of computers primarily at a teacher level, rather than at a managerial, or educational authority level.

As noted in Chapter One, there is little work on teachers' use of CAL which is specific to the FE sector, therefore the studies described in Chapters Two and Three derive primarily from other sources. Because FE has features in common both with schools (particularly with the focus on the teacher-student relationship, and on classroom-based study) and HE (with the focus on the education of adults and the importance of some degree of independent study), research carried out in both schools and HE was used to structure the field work for the thesis. This research is described in this chapter and Chapter Three, and has been divided into four broad groups, as follows. Chapter Two describes findings deriving primarily from large-scale surveys of, firstly, student-teachers, who are generally taking their first steps in using computers for teaching, and, secondly, practising teachers who are experienced users of classroom technology. Chapter Three describes some of the findings deriving from, firstly, studies which view teachers' use of technology within the context of the educational system, and, secondly, in-depth case studies of teachers' classroom use of technology.

Chapter Two is organised as follows:

Section 2.1 *Some historical aspects*. This section provides a framework within which the other studies are considered by reviewing two major policy documents on the use of technology in the UK educational system. The first document dates to the 1970s and the second to the mid-1990s. The second document, the Higginson Report (1996) is relatively unusual in the context of this literature review in that it specifically

addresses the FE sector.

Section 2.2 *Anxious trainee teachers and the need to look beyond their anxiety.*

This section reviews some of the extensive literature concerning trainee teachers and the factors influencing their use of technology during teaching practice.

Section 2.3 *Studies on “exemplary users” or the “computing elite”.* This section reviews studies where the aim was to uncover the specific characteristics (personal or environmental) shared by experienced users of classroom technology

Section 2.4 *Summary.* Here the main findings from the previous sections are summarised.

2.1 Some historical aspects

Concerns about the slow uptake of technical innovations in education are not new.

Hooper (1977) noted that by the early 1970s there had been

"growing concern in the educational technologist community at the lack of success with institutionalisation of educational innovation over the last two decades on both sides of the Atlantic" (Hooper, 1977, p. 15).

Cuban (1986) traces these concerns even further back in his review of American schoolteachers' use of technology since 1920.

Hooper's (1977) comments were made in his review of the National Development Programme in Computer Assisted Learning (NDPCAL) to which he was appointed Director in 1973 when it was set up by the National Council for Educational Technology (NCET). The stated aims of this programme were to

"develop and secure the assimilation of computer assisted and computer managed learning on a regular institutional basis at reasonable cost" (ibid., p. 15).

This was to be done via a variety (35 in total) of major funded projects and feasibility

studies in schools, polytechnics, universities and within the armed services and industries.

Hooper (1977) insisted that the traditional view of CAL had only limited application within the NDPCAL. This view, he said, derived from the North American tradition, and aimed to replace conventional teaching with computerised programmed instruction. By contrast, NDPCAL aimed to encourage programmes that demonstrated the breadth and versatility of CAL when used as an enhancement of conventional teaching. Hooper (1977) also noted the need for CAL to respond to current learning theories, and described the North American tendency to rely on behaviourist principles as problematic.

Hooper's (1977) report stressed the overarching aims of institutionalisation and transferability in NDPCAL's strategies. Institutionalisation was defined as the continued use and development of CAL and computer managed learning (CML) after the five years of NDPCAL funding had ceased. Transferability was defined as

"the systematic attempt to promote the spread of experience, new ideas and teaching materials" (ibid., p. 27),

and was considered vital in keeping development costs down.

The Programme's design addressed these aims by promoting

"teacher-led development and teacher-to-teacher diffusion [in an] acknowledgement and an endorsement..." (ibid., p. 59)

of the fact that teachers controlled, to a large extent, what types of technology gained access to the classroom. In recognition of the need for personnel involvement, very little of the NDPCAL money was spent on hardware and most on staff time for development. Despite this Hooper noted:

"paradoxically, a message coming out of the Programme is that the real difficulties surrounding CAL and CML are not primarily technical. What requires attention are the

human, political and educational environments" (ibid., p.125).

Twenty years on from the NDPCAL the technology has changed dramatically and the learning theories are in constant flux, but the issues of use remain largely the same.

In 1993 the Further Education Funding Council (FEFC) set up the Learning and Technology Committee, which was chaired by Sir Gordon Higginson. The Committee aimed to investigate how FE colleges were using technology, how beneficial such use was proving to be for learners, and how new developments in technology might influence learners. Beyond this its concerns were almost identical to the NDPCAL, that is, to investigate how the effective and beneficial use of technology could be increased, how good practice could be shared between colleges, and how its recommendations could be financed.

The final report of the Learning and Technology Committee, the Higginson Report, was published in 1996. The Higginson report shows evidence of more reforming zeal than Hooper's (1977) report, coupled with a tendency to avoid problematic issues. For example, the final report notes that one of the commissioned studies found evidence that

"many teachers are coming to terms rather reluctantly with information and learning technology. There is some suspicion that computers and resource centres are being used to drive down teaching hours with the principle aim of saving money" (Higginson, 1996, p.13).

However, whereas the authors of the commissioned report went on to say:

"it is fair to say that our evidence suggests that these suspicions were justified" (Gray and Warrender, 1995, p. 12),

this observation is conspicuously absent from the Higginson Report, which simply suggests that the suspicious teachers need "reassurance" (p. 13) from their college management on the importance of their role. This focus on "reassurance" provides a good illustration of what Hodas (1993) describes as the desire of

“Change advocates ... to have things both ways. On the one hand, the revolutionary potential of the innovation is emphasised, while at the same time current practitioners are reassured ... that their roles, positions, and relationships will remain by and large as they were before” (Hodas, 1993, p. 8).

Further to this point, the Higginson Report concentrates primarily on the Committee's recommendations rather than its findings about current CAL usage and the effects of such usage on learners; this gives the report a somewhat unbalanced feel. Whereas the NDPCAL Report (among others, such as the MacFarlane Report (1992) into use of technologies within HE) stressed the importance of rigorously evaluating any learning approach, the Higginson Report is in danger of giving the impression that any use of technology is valid and valuable for learners. For example, it implies that any members of the FE sector who are "sceptical" about the use of technology are also "uninformed" (Higginson, 1996, p.11). In this respect it differs sharply from the NDPCAL Report, which insists that it is important to recognise that individuals *involved in education may have quite different ideas about what constitutes "curriculum excellence"* (Hooper, 1977, p. 97).

Where both reports are similar is in the recommendations they make to their funding bodies. For example, the Higginson Report recommends that the colleges and their funding body (the FEFC) set up a jointly financed five year programme, the QUILT programme (see Section 1.1.2). At the end of this time the FEFC funding will be withdrawn and the sector will fund its own technological developments. Also in common with the NDPCAL Report, the Higginson Report emphasises the importance of developing demonstration projects to show effective incorporation of learning technologies and development of learning resources. Similarly, it encourages the establishment of a communication network between all colleges; the NDPCAL Report

recommended that this network should use existing channels of information, whereas the network suggested by the Higginson Report, as befits the increased technology, will be electronic.

An additional recommendation in the Higginson Report is that a national staff development programme and specialist advice centres be set up. This recommendation does not feature in the NDPCAL Report, and may be in response to the increased sophistication of computer technology and the difficulty individuals have with keeping pace with the rapid changes. Alternatively, or additionally, it may be that Hooper's (1977) hoped for institutionalisation and transferability have been a long time coming and staff development measures are designed to speed them up.

A number of papers on teachers and CAL explicitly address the difficulties in designing appropriate staff development programmes in order to equip teachers with the skills needed to be able to integrate CAL into their classrooms (e.g. Fullan, 1991). The next section illustrates some of these difficulties with respect to initial teacher training programmes.

2.2 Anxious trainee teachers and the need to look beyond their anxiety

There is a wealth of literature on IT and initial teacher training from a variety of countries. Much of this derives from HE teacher-training institutions, and seems to be in response to government pressures on these institutions to increase student-teachers' classroom computer use (e.g. Passey, 1998). Although the focus in this thesis is on practising rather than pre-service teachers, the studies described here are included because the participants are predominantly new to using computers in classrooms. By contrast, most larger scale recent studies on practising teachers inevitably include

participants with variable histories with respect to computer use. These studies on pre-service teachers therefore provide large-scale investigations into non-users' experience of starting to use computers in classrooms. Obviously, because of the different nature of the participant groups, some caution is needed when using these findings to inform the structure of this thesis.

Many studies from the 1970s and 1980s suggested that teachers' unfamiliarity with computers, and their anxiety about computers were acting as major barriers to teachers' use of technology in the classroom (Madsen and Sebastiani, 1987). This research often advocated staff development in computer literacy in order to decrease unfamiliarity and anxiety and increase use of computers. However, more recent research on student-teachers' attitudes towards computers indicates that the removal of anxiety and unfamiliarity do not necessarily result in increased computer use. The first study described in this section looks at the complex nature of computer attitude and computer literacy, and the following six studies investigate the relationship between a variety of factors, including attitude towards and familiarity with computers, and their use in the classroom.

Hignite and Echternacht (1992) surveyed a number of studies completed between 1982 and 1989 on correlations between, variously, computer attitudes, computer literacy, programming experience, prior computing experience and age. They note the contradictory evidence these studies produce. For example, they cite studies by Wiggins (1984) and Mercoulides (1988) which identify a significant relationship between individuals' computer literacy and their attitudes towards computers, and they also cite studies by Austin (1986) and Boos (1986) which find no such relationship. Hignite and Esternacht (1992) suggest the contradictory findings of such studies may

have resulted from the researchers oversimplifying complex situations and reducing them to just two variables during any one investigation.

Hignite and Esternacht's (1992) own study investigated several variables of attitude and computer literacy in 83 trainee business teachers who were enrolled at a variety of American teacher training colleges and universities. They identified four sub-groups of 'attitude towards computers' amongst these trainee teachers; these were computer anxiety, computer liking, computers as tools for teachers (with a focus on administrative tasks) and computers in education (with a focus on pedagogical value). They also identified two sub-groups of 'computer literacy'; these were computer applications (with a focus on knowledgeable use of computers in a variety of situations) and computer systems (with a focus on a more technical understanding of software and hardware).

The study found that the trainee teachers had generally positive attitudes towards the use of computers in education; this was anticipated by the researchers and, it was noted, was in line with similar studies into trainee business teachers. More surprising was the lack of any significant correlation between the computer applications variable (which concerned the knowledgeable *use* of computers) and any computer attitude variables (such as anxiety or liking). There were however links between the computer *systems* variable and the anxiety variable. The authors suggest this may show that computer anxiety is related only to the *technical* aspects of computer literacy, rather than the ability to use computers in a knowledgeable fashion. They further suggest that there has been too much emphasis on the importance of technical knowledge about computers, rather than knowledgeable use of them. The importance of knowledgeable use is stressed by a number of other authors, such as Weizenbaum (1993) who describes

it as "technology savvy" (Weizenbaum, 1993, p. 71), and insists it is crucial for the effective use of computers in a way in which technical knowledge is not.

Aside from this finding, Hignite and Echtenacht (1992) stress that it was not possible to draw any firm conclusions from their study. They note:

"What can be inferred from the main results of this study (and possibly the contradictory results of prior studies) is that the relationship between computer attitudes and computer literacy is neither direct nor simple" (Hignite and Esternacht, 1992, p. 387)

and they stress that

"[Although] both positive attitudes towards computers and adequate computer literacy skills are critical to the successful incorporation of new technology into the classroom, unfortunately, teacher preparation programs may operate under the assumption that an emphasis on computer literacy will automatically bring about positive attitudes toward computers, or that positive attitudes toward computers are indicative of a successful mastery of computer topics" (ibid., p. 388).

Studies by Dunn and Ridgway (1991a, 1991b) provide an illustration of the lack of correlation between positive attitudes towards computers, increased computer literacy and increased classroom use of CAL. They found that there were generally positive attitudes towards computers in education in their sample group of 109 second year B.Ed students at a UK teacher training institution (1991a). However, this enthusiasm was not translated into action and a survey into the student-teachers' use of computers on their first teaching practice revealed

"a depressing picture of very low spontaneous computer use" (Dunn and Ridgway, 1991a, p. 6).

The student-teachers were offered several statements to explain their reasons for not using computers; the most commonly cited reason was lack of confidence/ expertise.

The same students were then surveyed after their final teaching practice (1991b), using a similar questionnaire. This second survey showed an overall increase in the

percentage of students making use of computers, but the level was still rated as "unacceptably low" (Dunn and Ridgway, 1991b, p. 237). The students who had taken an optional 150 hour computer studies course in their first year were identified, and their questionnaire responses compared with the rest of the students who had only had a 15 hour computer awareness course. The computer studies students had fewer technical problems, but the authors note that although

"these students were significantly more confident about using IT than others ... [they] were no more likely to use it on their teaching practice" (ibid., p. 239).

This pattern of

- educators' positive attitudes towards computers in education
- their low use of computers in teaching
- their identification of general anxiety or unfamiliarity with the technology as the cause of this low use,

has also been identified in a number of studies on practising teachers (Dupagne and Krendl, 1992).

A slightly different perspective is provided in an Australian study by Downes (1993). Downes investigated the computer use of 372 teacher trainees who were undertaking their first, second or third year teaching practice. The study dealt with a wide variety of factors, elucidated from questionnaires supplemented with open-ended questions, interviews and group discussions.

Teacher trainees who did not use computers during their teaching practice were asked for reasons; interestingly, lack of confidence did not feature strongly here. The three main reasons came into the following categories:

"the idea didn't occur to me" (although very few third year students cited this)

"the class didn't have access to computers while I was there"

"it didn't fit into the planned activities or units of work" (Downes, 1993, p.28).

The study findings indicated that the teaching practice environment was particularly important in encouraging or discouraging computer use. This included the resource provision, since inadequate resources emerged as a major barrier to classroom use of computer technology. The teaching practice environment also included the "computer-use climate" (ibid., p. 29), and Downes found that despite an overall increase in use across the three years, a first year trainee teacher placed with a computer-using supervisor teacher was more likely to use computers in the classroom than a third year student who was not. Expanding on this, Downes notes:

"the relationship between personal use and use with children is not straightforward ... use with children can precede personal use" (ibid., p. 33).

Downes (1993) concludes that the development of general computer skills amongst the trainees was valuable in promoting the use of computers in classrooms, and was particularly encouraged by possession of a home computer. The importance of access to computers at home has also been stressed by a number of other studies on in-service teachers (e.g. Robertson, 1996; Somekh, 1989). However, Downes (1993) insists that the main focus within teacher-training courses needs to be on how to use computers specifically with children/students.

The importance of familiarity with computers in specific classroom contexts is also stressed by Wild (1995). His study included a survey of 161 second year education students who had just completed a ten day teaching practice session. This study provides interesting information about the barriers to CAL use which lie beyond resourcing and general IT competence. The student-teachers had all completed a general IT skills course before their teaching practice, and nearly half indicated that during the practice they had had "satisfactory access to a computer for teaching

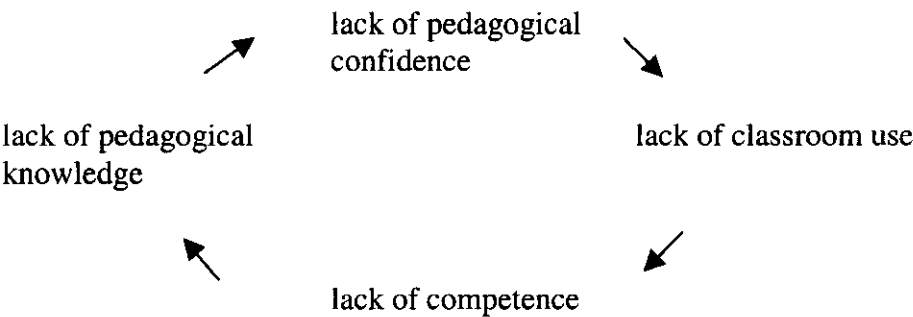
purposes" (Wild, 1995, p. 13). Despite this, over 80 percent made no use at all of IT during the session, and only 7 percent used computers in their teaching more than once.

Wild (1995) found these low levels surprising, particularly as the students also recorded that 72 percent of their supervising teachers had used the computer at least once during the period, and 39 percent had used IT in the classrooms almost every day. He suggests that, although

"[a number of studies] indicate a positive correlation between supervising teacher use and student use of IT on practice; the data here suggest that this correlation [may need] to be re-examined" (Wild, 1995, p. 13).

When the students were asked to comment on their lack of IT use, they highlighted three main reasons. These were, firstly, insufficient access to suitable software, secondly, lack of knowledge about classroom use of IT and thirdly, lack of confidence in using computers in the classroom.

Wild (1995) draws parallels with these findings and the findings from a study by Haywood and Norman (1988). Haywood and Norman (1988) suggested that teachers' confidence in using IT appeared to allow them to develop added competence, which in turn further promoted IT confidence and so on. Wild (1995) suggests that this cycle can be modified to represent the following:



He stresses the need for teacher education establishments to develop courses which explicitly address the fact that

"uptake of IT use in the classroom is undermined by a lack of confidence to use IT in the classroom which is, in turn, related to a lack of knowledge about classroom uses of IT" (ibid., p. 14).

A number of studies stress that practising teachers also see poor resourcing (both of hardware and software) and lack of specific classroom knowledge of computers as inhibiting their use of classroom technology (Grunberg and Summers, 1992; Hoffman, 1996).

In summary, the articles in this section indicate the following:

- student-teachers generally have a low rate of computer use during teaching practice
- they often focus on their general unfamiliarity with, or anxiety about, computers to explain this
- their attitudes towards the use of computers in education are generally positive
- the relationship between increased computer literacy, positive attitudes towards computers, and increased computer use in classrooms is neither linear nor straightforward
- inadequate access to computers (primarily at work, but secondarily at home for the development of general skills) is a major barrier to use of CAL
- exposure to the classroom practice of computer-using teachers may be important in student-teachers' development of classroom knowledge about, and confidence in, the use of CAL.

2.3 Studies on "exemplary users" or the computing "elite"

The studies in Section 2.2 highlighted some of the barriers to classroom use of computers as experienced by non-users of classroom technology. This section examines three broad, survey-based studies on the attitudes and work environments of teachers who make considerable use of computers in their teaching. In doing so these

studies enable their readers to look beyond the initial barriers to classroom use, and to see what further barriers experienced users have overcome, or still face. One of these studies (Becker, 1994) concentrates on examining the relationship between teachers' computer use and factors such as resourcing levels, gender and qualifications. The other two (Denk, Martin and Sarangarm, 1993-94; Sherwood, 1993) concentrate on teachers' perceptions of issues to do with computer use. Two are concerned with school teachers and one with HE lecturers.

Denk, Bruce and Sarangarm's (1993-94) study examines academic computing at three universities. This study involved a survey of 302 faculty members from six subject areas. These members were all experienced in using computers and are described by Denk et al (1993-94) as the "computing elite" (p. 54) who had a "known orientation towards instructional usage of computers" (ibid., p. 49).

Because university students are expected to cover a considerable amount of work in their own time, this paper is able to reveal some interesting discrepancies between teachers' use of computers inside and outside the classroom. Only 25 percent of respondents used computers in a way which was described as "integral to the classroom experience" (ibid., p. 42), for example for presentations, experimental data analysis or for programmed instruction. By comparison, 61 percent of respondents said they would normally direct students to use computers as tools for self-study or for assignment completion.

In trying to establish reasons for such usage Denk et al (1993-94) used two sets of questionnaires. The first set was designed to assess attitudes towards overall computer use, and use inside and outside the classroom. The second set was designed to assess perceptions about hindrances to the use of computers, again, both inside and outside the

classroom.

As expected, responses to the first set of questionnaires showed that these respondents were in general agreement about the use of computers to improve educational quality. The respondents showed considerable agreement on the benefits of using computers for the following: doing tasks which cannot be done without computers (a rather tautological item), accessing information and giving freedom to experiment. The respondents felt the computer was least valuable for the following: making it easier for students to learn difficult concepts, decreasing class time spent on basic course information, and dealing with different student abilities and learning styles.

The questionnaire items were divided into two categories: those which described aspects that were to do with classroom use of technology, such as:

"Make it easier to deal with difference in learning styles of students in the same class" (ibid., p. 46)

and those that were not classroom specific, such as:

"Improve student attitude towards subject matter" (ibid., p. 46).

The researchers found that opinions about aspects that were classroom specific were less positive (at 58%) than those that were not (81%).

The second set of questionnaires asked about hindrances to the instructional use of computers. The three items which were seen as representing the greatest perceived hindrances were funding and training, maintaining up to date knowledge and the extra time needed for preparation. The three items perceived as representing the least hindrance were lack of interest, availability of software and technical problems (such as insufficient memory in the hardware or incompatible software).

Once again these items were divided into those which were concerned with

computers in the classroom and those which were not; again more problems were perceived with the former (61%) than the latter (45%).

The study points to the need for a thorough, and possibly more open-ended examination of the balance between the perceived usefulness of computers in classrooms, and the perceived hindrances to such use. Although the study outlines the relationship between the two, it does not explore it. Similarly, the authors conclude that there is a need to

“[Integrate computers] into the regular curriculum in order to introduce, reinforce, supplement and extend skills that are already taught” (ibid., p. 54), and they provide recommendations for increasing such integration without examining their

“somewhat surprising [finding] that these users of computing are not totally convinced that classroom use of computers is worthwhile” (ibid., p. 39). It may be one of the drawbacks of this type of study that it does not have sufficient flexibility to explore issues such as these.

In general, the study provides a good illustration of Hurley’s (1992) insistence that the use of technology in any set up must be preceded by a perception of the need for that technology. Hurley criticises the “rationalistic fallacy”, that is, the

“rather naïve expectation that the simple fact of the introduction of the ‘right’ technology will lead to the actual and extensive use of that technology” (Hurley, 1992, p. 20).

He summarises this as “introduction = use” and insists that if technology is to be fully utilised the model must be:

“perceived usefulness – introduction – use” (ibid., p. 23).¹

Denk et al’s (1993-94) study demonstrates the importance of “perceived usefulness” in that, even though the study participants were extensive users of educational technology they still would not use computers in classrooms if the perceived usefulness of this was outweighed by the perceived problems.

The second article in this section describes a survey by Sherwood (1993) of 362 “experienced users of computer technology in the classroom” (Sherwood, 1993, p. 169) from across the Australian schooling system. The survey respondents were either self-nominated, or selected by the school or educational authority, and the survey sought their views on the factors influencing their use of computers. Sherwood summarises the main questions behind her research as follows:

“What barriers are experienced by teachers in the process of integrating technology into the curriculum? What are the incentives (those beliefs and experiences) which have encouraged teachers in their use of computers in the classroom? Do teachers feel that their pre-service and/or in-service training provides them with sufficient knowledge and expertise enabling them to be competent and confident users of technology?” (ibid., p. 168).

Sherwood (1993) found that the respondents’ main motivation for using computers was for their educational potential, rather than because they felt their students needed to be technologically skilled. As part of this, almost 76 percent felt that computers had

¹ Identification of the features which will contribute towards such “perceived usefulness” in educational technology is, however, not easy. For example, Draper (1998) contests that “there are no generalizations about what features of technology or software type makes a piece of CAL successful” (Draper, 1998, p. 5). He instead proposes that such success is niche-based, and is particular to the context within which the CAL is used. He suggests that “The best cases of applying CAL to improve learning will combine 1. an identification of a real pedagogic problem; 2. a pedagogic theory of how the educational intervention is a solution to the pedagogic problem; 3. a neat bit of CAL design” (ibid., p. 8).

made a difference to their teaching, particularly in encouraging a move to more student-centred classes. Sherwood notes that for most of the respondents:

“ the advantages offered by computers to enhance their teaching is sufficient to overcome the problems and barriers that they also recorded in the survey [and] the computer has been a major force in reshaping their curriculum and their own beliefs about teaching and learning” (ibid., p. 172).²

Sherwood’s (1993) findings on the teachers’ perceptions of the barriers to classroom use are in line with Denk et al’s (1993-94) findings. The most significant barrier recorded by the teachers was a lack of funding, leading to a shortage of computers and a shortage of personnel to co-ordinate CAL implementation. The second major barrier was *lack of time and training needed for teachers to develop their technical skills and the skills needed to integrate computers into the curriculum*. With respect to staff development, Sherwood stresses:

“Specifically, there is a lack of access to appropriate preparation and support. The training (pre-service and in-service) does not prepare teachers to integrate computers into their teaching, it does not include enough time for them to become comfortable with the software, nor does it include support to help them troubleshoot during the early implementation stages and the training experience is not tailored to their needs” (ibid., p. 174).

An additional finding from this study was the issue to do with age and/or experience. Sherwood notes, somewhat to her surprise, that these teachers were “a mature and experienced group” (p. 169) with, firstly, nearly half being between 35 and 44, secondly, 61 percent having been teachers for 13 years or more, and thirdly, almost

² Researchers who focus on teachers’ educational beliefs countenance caution with respect to suggestions that such beliefs are amenable to change. For example, Pajares (1992) notes the weight of research which suggests that student teachers are already ‘set’ in their beliefs by the time they start their teacher training, and that “the power of beliefs can easily outweigh the clearest and most convincing contrary evidence.” (p. 17).

half having used computers for more than seven years. Studies on the effect of length of teaching experience on classroom computer use often reveal contradictory findings, however the consensus appears to be that several years' teaching and computing experience are required before teachers are able to start using computers effectively and fluently in the classroom (Carey and Sale, 1993). This finding is discussed further in relation to the third paper described in this section.

This final paper describes a study by Becker (1994) on the use of computers by American elementary and secondary school teachers. This study also used extensive questionnaires to a large number of teachers, but differed from Denk et al's (1993-94) and Sherwood's (1993) studies in gathering data which was not concerned with perceptions. The aim of Becker's (1992) study was to investigate how "exemplary" computer-using teachers differed from other teachers. Questionnaires were sent to a total of 516 teachers, all of whom used computers. Analysis of the questionnaires identified 45 of these teachers as exemplary on the grounds that they showed

"systematic and frequent use of computer software for activities that involve higher order thinking ... such as interpreting data, reasoning, writing, solving real-world problems, and conducting scientific investigations" (Becker, 1994, p. 316).

Becker (1994) stresses that the study made no attempt to assess whether the "exemplary" computer use translated into better quality learning for students.

Becker's analysis of the differences between exemplary and other computer-using teachers reveals the importance of a number of personal and environmental factors. Personal factors included the amount of time spent working on computers at school, gender, and number of years spent teaching. With respect to gender, he observed that the percentage of men in the exemplary computer user group was higher than their percentage in the original sample, and noted that this could not be completely explained

by the fact that they spent more time on computers.³ With respect to experience, Becker, corroborating Sherwood's (1993) findings, found that exemplary teachers had more general teaching experience (on average, three years) and more experience in using computers in teaching (on average, one year) than non-exemplary teachers. Becker (1994) notes that these findings are in line with survey findings by Sheingold and Hadley (1990) who concluded that at least five years of computer use were required to develop classroom computer expertise⁴.

The most significant difference between the two groups of teachers, however, was found in the work environment. Becker noted that

"the largest difference between exemplary and other computer-using teachers was simply the total number of teachers at their school who used computers" (ibid., p. 303).

Exemplary teachers were based in schools with nearly twice as many computer-using teachers, and were particularly found where

"the other computer-using teachers [were] also competent users" (ibid., p. 303).

Becker's findings in relation to the importance of colleagues' use of computers corroborate Downes' (1993) findings, and indicate the similarities in the experiences of pre-service and in-service teachers.

³ The literature on gender and computer use is often contradictory. This contradiction is often to do with how far males and females have differing attitudes towards computers and/or differing use of computers, and how far the two may be related (e.g. Robertson et al, 1995; Wood, 1998).

⁴ A number of authors, for example Somekh (1998), explain this by suggesting that individuals need to pass through a series of sometimes lengthy stages, including orientation and a routine low-level use, before achieving full integration of an innovation and the ability to use it creatively.

Less significant, but still influential were resourcing issues. These included the number of computers per capita, the amount of software, and whether the school had a full-time computer co-ordinator and formal staff development, both in the use of general applications and in the use of computers in their subject specialism. Becker (1994) found that the most significant resourcing aspect was smaller class sizes, with exemplary computer-users having, on average, 20 percent smaller classes. He stresses:

"Whether it was smaller class size that caused exemplary computer use or whether exemplary teachers more successfully claimed the right to smaller classes, these finding emphasise that effective teaching with computers may be costly not only in terms of hardware, software, training, and human support but also may require the costliest element of all - more teachers" (ibid., p. 306)

Finally, Becker returns to the issue of pedagogical quality. He stresses the need, particularly bearing in mind the cost of effective implementation, for research to establish whether the money could be better spent in other ways (e.g. smaller classes, more staff development, increased planning time for teachers), and whether exemplary computer use actually translates into improved student competencies.

In summary, the articles in this section indicate the following

- good resourcing levels are crucial for the full integration of technology; these include hardware, software, support personnel, time and training
- experience in teaching generally, and specific experience of using computers in teaching are likely to be prerequisites for the development of extensive classroom computer use
- teachers' use of CAL may be influenced by their colleagues' use of CAL
- teachers' perceptions of the usefulness of classroom technology is important in determining their use of it
- teachers may need to weigh up the benefits of using CAL in classrooms against the

specific problems of classroom integration

- gender may be important with respect to teachers' use of CAL.

2.4 Summary

Studies on non-users of classroom technology reveal that general anxiety about, and unfamiliarity with, computers is often cited by these non-users as a major barrier to their use of classroom technology. However, research shows that increased computer literacy does not necessarily equate with increased use of computers in the classroom. This suggests that general anxiety and unfamiliarity represent the *first*, not the *only*, barrier teachers face when moving from being non-users of classroom technology to being extensive users who can fluently integrate computers into their classroom practice.

Research on both non-users and experienced users emphasises the impact of the "computer-use environment" on teachers' classroom computer use. This environment includes both resourcing levels and colleagues' computer use. With respect to resourcing, the main focus in the studies is on hardware resourcing in the workplace. However, the importance of access to computers at home is also emphasised, as is the importance of access to other resources such as software, technical support and co-ordination, staff development and teachers' time. With respect to the influence of colleagues, the computer-use environment is considerably enriched by mentors/colleagues who make extensive use of computing in their own teaching. Two studies in particular (Becker, 1994; Downes, 1993) found that this was the most significant factor impacting on pre- and in-service teachers' use of computers. Becker (1994) also found that the impact was intensified when the colleagues were using computers in a competent fashion.

Research on teachers who use computers extensively in their teaching stresses the important role time plays in the development of their pedagogical computing expertise. One of the papers (Becker, 1994) also indicates that gender may be important here.

Perceptions of the usefulness of software also appear to be crucial in influencing the extensive use of CAL in experienced teachers. In one of the studies (Denk et al, 1993-94) it emerged that the teachers appeared to weigh up this apparent usefulness against the problems of incorporating CAL into their classroom practice. This study suggested that such incorporation was often seen as problematic.

The next chapter reviews studies which place issues of incorporation into classroom practice at the centre of their fields of investigation.

Chapter Three: Studies on the Nature of Classroom Practice

Chapter Two described studies that highlighted the importance of a number of factors, both personal and environmental, affecting teachers' use of CAL. The research described was based primarily on broad surveys. Although classroom practice emerged, from one of the studies in particular (Denk et al, 1994-95), as playing an important role in teachers' CAL use, there was little emphasis on the precise nature of this role.

The research described in this chapter addresses classroom practice from two different perspectives. The first perspective is essentially 'top-down', in that it views the activities which take place inside the classroom within the context of the powerfully-shaping forces of the educational system. The second perspective is essentially 'bottom-up', in that it investigates classroom activities via a number of in-depth interviews and classroom-based observations. The chapter is organised as follows:

Section 3.1 *Teachers in context*. This section outlines 'top down' studies which examine teachers' beliefs and classroom practices within the context of educational establishments.

Section 3.2 *Classroom practice*. This section describes case study research into classroom practice, and draws conclusions about the factors which shape this practice.

Section 3.3 *Summary*. The main findings outlined in Chapter Three are summarised here.

Section 3.4 *Conclusions*. In this section the findings from Chapters Two and Three are drawn together to identify a number of factors for exploration in the thesis fieldwork.

3.1 Teachers in context

This section reviews selected work from three authors (Cuban, 1986, 1993; Hodas, 1993; Loveless, 1996) who write on issues to do with educational change.

Cuban (1986, 1993), is a one-time teacher turned educational administrator. His review of the use of technology in the classroom since 1920 (1986) places the under-utilisation of the computer in context, with an examination of the literature on the introduction into North American schools of radio, film and instructional television. In this he identifies an "unrelenting" pattern, which he describes as an

"exhilaration/scientific-credibility/disappointment/teacher-bashing cycle [which draws] its energy from an unswerving, insistent impulse on the part of nonteachers to change classroom practice" (Cuban, 1986, p. 5).

Cuban (1986) attributes the limited adoption of most of these major types of technology to the conflicting needs for both constancy and change which are both determined by, and determine, the overall culture of educational establishments and the nature of the teaching profession. He views this profession as essentially conservative.

This is because teaching is one of the few jobs where

"practically everyone learns firsthand about the job while sitting a few yards away, as students, year after year" (ibid., p. 59),

and because those who go into the profession tend to be those who flourished within the system, and are therefore less inclined to seek radical changes. Additionally, he suggests that for new teachers the complex business of trying to establish routines which will allow them to

"maintain control, teach a prescribed content, capture student interest in that content, match levels of instruction to differences among students, and show tangible evidence that students have performed satisfactorily" (ibid., p.57)

will tend to make them fall back on effective routines which they witnessed as students.

Cuban (1986) points to the 19th Century mandates for education as the source for the work practices which have remained so constant within classrooms and schools. These mandates specified that students should be compelled to attend schools and behave in an orderly fashion while receiving specified knowledge and values. The self-contained, age-graded class structure, with the teacher at the front, student essentially desk-bound and rules and regulations specifying who speaks and who listens, are therefore seen as

"resilient, simple, and efficient solutions in dealing with a large number of students in a small space for extended periods of time." (ibid., p. 57).

Within such a structure the most commonly used props are those which are simple and durable and are seen to fulfil specific, teacher-defined problems. Therefore chalk and textbooks abound, whereas anything that is perceived as inflexible, inaccessible or delivering poor quality material, is shelved. Additionally, Cuban (1986) emphasises the importance in terms of job satisfaction of the bonds between teacher and students, and observes that any device which tends to disrupt such bonds will have a negative reception.

Cuban (1993) proposes that the prime reason for the uptake of computers will be because they, unlike the other technologies he reviews, have become indispensable in the world of work; therefore their incorporation into education will be inexorable, because education always adapts to the nature of work in society. However, he also echoes Becker's (1992) concerns that further investigation is needed on the impact of computers within education on social climate, collaborative work and the teacher-student relationship. Both these authors also stress the need for more research into the cost-effectiveness and the positive benefits of computers on students' learning.

Hodas (1993) notes his agreement with much of Cuban's (1986) perspective on

computers and schools. He particularly addresses the differing agendas of classroom teachers, and of reformers whose

“goal is to make schooling more efficient through the manipulation of its objects or processes” (Hodas, 1993, p. 6).

He argues that this specific focus on efficiency often leads to the impoverished view of educational establishments as sites of “instructional delivery” (ibid., p. 7)¹. In his view:

“This didacticism [ignores] the rich, tumultuous contradictory social processes that situate the student, the teacher, and the school within society” (ibid., p. 7).

Hodas (1993) insists that it is not helpful to view educational establishments as institutions capable of purely rational response. He describes schools in particular as

“Entrenched or mature organisations [which] (like the organisms to which they are functionally and etymologically related) experience change or the challenge to change most significantly as a *disruption, an intrusion, as the failure of organismic defences*” (ibid., p. 2).

Within this model, teachers play their part as individuals who have initially acquiesced to, and subsequently come to defend, their inflexible, teacher-centred roles.

Using the model, Hodas (1993) stresses that the types of technology likely to be taken up by schools are those which fit into, rather than challenge, the organisation. Like Hooper (1977) (see Section 2.1), he criticises much of the drill-and-practice available in North American schools, but suggests such technology is often well received because it represents a

“behaviorist fantasy [which] fits neatly into the organizational model of schools, and into much pedagogical practice as well” (Hodas, 1993, p. 11).

¹ This view is common in much of the literature on educational change (Doyle and Ponder, 1977), for example: “The aim of school is to help people to acquire knowledge and problem solving skills in defined fields and to explore the best methodologies to reach this aim” (Bottino et al, 1998, p.164)

He is, however, optimistic both about the changing nature of software development, and, like Cuban (1993), about the capacity for schools to change in response to wider social change, albeit slowly. Hodas (1993) notes:

"what this underlines, I think, is that machines can indeed change the culture of organisations, even ones as entrenched and recalcitrant as schools have proven to be ... This shift is not instigated by the machines deployed within schools but those outside of it, those that shape and organise the social, economic, and informative relationships in which schools are situated and which they perpetuate" (ibid., p. 14).

The third article in this section is by Loveless (1996), an educational technologist, who describes the constraining structures of schools in much the same way as Hodas; however, Loveless' focus has a more practical direction. He suggests that there are two major barriers to classroom use of computers; the first is to do with the availability of computers, and the second is to do with the classroom teachers themselves. With respect to availability of computers, Loveless (1996) points out that there are extensive problems of accessibility in many schools, exacerbated by the tendency to gather available computing resources centrally. He notes:

"This arrangement provides students with equitable and efficient exposure [but limits] technology's accessibility for classroom instruction, [denies] teachers the flexibility of deciding when technology should be incorporated into instruction, [and unwittingly conveys] to students that computers are not central to learning and certainly not central to the activities of their classrooms." (Loveless, 1996, p. 451).

Loveless suggests that this deployment is symptomatic of the fact that purchase of technology has often occurred without sufficient consideration about why computers were needed and how they would be used.

Although accessibility is critical, Loveless (1996) notes that the "most frequently cited obstacle" (p. 455) to classroom use of computers is the classroom teacher. He observes that the reluctance on the part of classroom teachers to use technology is often

blamed on their lack of technological knowledge. His perspective is:

“granted, teachers should know more about new technology. But they know quite a bit about teaching, certainly ... more than most non-teaching pedagogical pioneers, who judge current practices against a backbone of reform agendas, not against the day-to-day imperatives of classrooms” (ibid., p. 455).

Like Hodas (1993), Loveless (1996) views many of these reform agendas as problematic, in that they ignore the “messiness” (p. 450) of real classrooms, and “simultaneously identify the teacher as both problem and solution, as the factor that must be changed, and as the agent of that change” (ibid., p. 457).

Loveless suggests that an adversarial stance on the part of the “computer movement” (ibid., p. 457) is counterproductive. He argues that in order to increase the amount of computer use in education, computer advocacy needs to be separated from other educational reform agendas, and computer activities need to be adapted so that they fit with the beliefs and current practices of classroom teachers. In short, Loveless proposes that computer advocates

“stop approaching the task as one of getting teachers to do their jobs differently and begin helping teachers to do their jobs as they do them now. This is hardly revelatory, for it describes the conditions that have favored the spread of innovations in other professions.” (ibid., p. 464).

In summary, the four studies described in this section highlight the following:

- the educational establishment’s resistance to change is not new, and encompasses resistance to a wide variety of innovations
- much of this resistance is rooted in the changes the innovations require to the defining structures of the establishments and therefore to teachers’ sense of identity
- this sense of identity is largely tied up with teachers’ general working practices and relationships with students, that is, with aspects which are most strongly expressed

in classroom practices

- classroom practices evolved as "resilient, simple, and efficient solutions in dealing with a large number of students in a small space for extended periods of time."
(Cuban, 1986, p. 57)
- innovations which fit into these current practices are more likely to be adopted than those which challenge it
- schools are likely to change in response to societal changes, but these will be slow
- inadequate resource levels act as major obstacles to computer use in classrooms.

These four studies provide a useful backdrop against which research on classroom practice can be viewed. However, three points need to be made here. The first is that Cuban (1986, 1993), Hodas (1993) and Loveless (1996) are concerned primarily with the North American education system, and, as noted in Section 2.1, there are significant historical differences between the North American and UK approaches towards CAL implementation.² The second, and possibly more important point, is that these authors are concerned with practice in schools and that this may be very different to practice in FE. For example, Loveless (1996) refers to the "essential nature of teaching and learning" in schools as being determined by

"the involuntary nature of schooling, the immaturity of children as a class of workers, and the dominance of written instruction" (Loveless, 1996, p. 464).

² However, their observations, particularly Cuban's (1986), are considered important and relevant by a number of authors who comment on the UK school system (e.g. Crooks, 1996).

By contrast, in FE attendance is usually voluntary and the students are adults. So despite the fact that teaching within FE appears to relate closely to teaching in schools, caution is needed when extrapolating from these studies to FE.

The third point is that teachers emerge from these studies as being fundamentally static in their practice and primarily fixed into concerns about maintaining their teacher-centred classroom roles.³ Other commentators on educational change (e.g. Fullan, 1991), by contrast, emphasise the active considerations teachers often make when judging the need for change, and the powerful self-motivation many teachers reveal when they believe change is necessary. Fullan (1991) describes the main criteria teachers use as follows: first, the teachers establish whether the innovation addresses a need; second, they establish what they will need to do in order to implement the change; third, they judge how it will affect them personally; fourth, they judge how rewarding it will be in terms of their interactions with others. Fullan (1991) notes:

“personal costs in time, energy, and threat to sense of adequacy, with no evidence of benefits in return, seem to have constituted the major costs of changes in education over the past 30 years. On the other hand, when the changes involve a sense of mastery, excitement and accomplishment, the incentives for trying new practices are powerful” (Fullan, 1991, p. 129).

Some of these “powerful incentives” were evident in Sherwood’s (1993) study (see Section 2.3) and also emerge from the ‘bottom-up’ case studies discussed in the following section.

³ Doyle and Ponder (1977) suggest that three images of teachers emerge from much of the literature on educational change. These are the rational adopter, the stone-age obstructionist and the pragmatic sceptic. To a large extent the articles in this section (and other articles mentioned in this thesis, e.g. Hannafin and Savenye, 1993), while they may be sympathetic about the difficulties teachers face, appear to represent them as stone-age obstructionists.

3.2 Classroom practice

Doyle and Ponder (1977) suggest that teachers respond to innovations on the basis of a “practicality ethic” (p. 1). They note:

“The essential features of this ethic can be summarised briefly as follows. In the normal course of events teachers receive a variety of messages intended to modify or improve their performance. If one listens carefully to the way teachers talk about these messages, it soon becomes clear that the term “practical” is used frequently and consistently to label statements about classroom practices.” (Doyle and Ponder, 1997, p. 1-2).

Examinations of classroom practices, and how these practices influence, and are influenced by, adoption of innovations, are relatively rare. Where such examinations do occur, however, the researchers seem clear that classroom practices hold the key to explaining individual teachers’ responses to change.

Issues to do with classroom practice emerge most clearly from in-depth case studies involving interviews and classroom observations where “careful listening” is possible; this section addresses four such studies. The first part, Section 3.2.1, describes three studies which derive from the UK, the Netherlands and North America; they specifically address teachers’ use of technology in the classroom. Section 3.2.2 describes the fourth study, which is also from the UK. This differs from the studies described in Section 3.2.1 in that it aims to provide a model for classroom practice per se, without necessarily considering the influence of technology. The model it describes is used later in the thesis.

3.2.1 *Classroom practice and educational technology*

The first paper in this section describes a study by Watson (1993a) on the use of classroom technology by UK geography teachers. The study itself was part of the

Impact Project (Watson, 1993b) which was a DES-funded project, set up to assess the influence of IT on students' achievements in UK schools. This was done by monitoring pairs of classes, where one of the pair made regular use of IT and was designated 'HiIT' and the other made little use of IT and was designated 'LoIT'.

The Impact Project was broad ranging, involving over 2300 students, and covering mathematics, science, geography and English in 87 different classes. One of the main strands of the project consisted of a series of case studies with nine HiIT classes. During these case studies it became clear to the researchers that the curriculum implementation of IT in any one department was primarily dependent on the actions of individual teachers. In the final Impact Project Report Watson also notes:

"the case study team came to appreciate at first hand the combination of seemingly minor problems that in any one day makes using IT with a class an effort rather than the norm" (1993b, p. 96).

The research described in this section focuses on a sub-group of the case studies, that is, those which were carried out with five HiIT geography teachers. The teachers were observed, and they and their students were interviewed over a two-year period.

The teachers were, as might be expected, confident in their use of classroom educational technology. Watson notes that

"this confidence in use ... came principally from within the character of the teachers themselves and their history of experience with IT" (1993a, p. 272).

They were all able to deal with technical mishaps which occurred during the class, and were realistic about the way in which IT could support their teaching. Watson (1993a) stresses that this realism played an important part in the teachers' successful use of IT. She also stresses that the teachers used the IT

"to support their existing pedagogy and practice, which itself was often innovatory" (ibid., p. 272).

However, despite the fact that these teachers were using IT extensively and effectively, and despite the fact that they had good relationships with their colleagues, who were also

"confident and creative practitioners of geography teaching ... [the HiIT teachers'] enthusiasm and use of IT had not influenced their colleagues who remained on the whole rare and reluctant users of IT" (ibid., pp. 272-271).

Findings indicating the *lack* of influence of computer-using teachers on their colleagues are relatively rare, but Watson's (1993a) observations have some similarity to Wild's (1995) (see Section 2.1).

Watson makes two main observations about the "IT gulf" (ibid., p. 272) which had opened up between the HiIT user and their colleagues. The first observation is that the diffusion of good practice through teacher collaboration in the departments was made very difficult by the demands of the curriculum and the corresponding squeeze on teachers' time. Watson (1993a) suggests in response to this that staff development time needs to be made available to teachers in order for them to be able to share their expertise.

The second observation is to do with how the HiIT teacher was viewed by their colleagues. Watson (1993a) notes that it became apparent that

"successful use had become associated in colleagues' minds more with the individual characteristics of the user, than the nature of the conditions that IT could create that were favourable for effective teaching. So the very particular nature of the enthusiasm of their IT using colleague was an inhibitor." (ibid., p. 273).

In the light of this she suggests that any staff development initiatives

"must also consider how to depersonalise the innovation from the user" (ibid., p. 274).

The second paper to be described in this section comes from an in-depth longitudinal set of case studies carried out in the Netherlands. The paper, by Veen

(1993), concentrates on the role of teacher beliefs in the use of information technology. It provides a contrast to Watson's (1993a) study in its focus on novice users of educational technology.

The research took place over a three year period and involved interviews with, and classroom observations of, four teachers from the same secondary school. The four teachers had different subject specialisms, variously mathematics, history, English and French, and were all described as having good reputations. They kept diaries of their computer use at home and at work, and these were used as the basis for interviews every three weeks. Additionally in-depth interviews were carried out with the teachers, principal, technical assistant and IT co-ordinator every six months.

The main question underlying the research was:

"if they have adequate resources, what are these teachers going to do with computers at school and at home and how can their choice of computer-related activities be explained?" (Veen, 1993, p. 140).

In order to provide these "adequate resources" the teachers were each given a computer to use at home, and a computer and "transviewer" for use in the classroom.

Additionally the school was provided with a computer laboratory. Before the research period began, the teachers attended a standard training course on CAL, and were given an overview of the CAL available for their subjects.

Veen found that all four teachers made regular and similar use of their computers at home. However, they varied extensively in their classroom computer use. For example, the English teacher stopped teaching with computers at the end of the first year. This teacher felt that the sessions during which he used the computers were less effective than his usual sessions because

"using computers made him deviate too much from his existing teaching skills and he

did not succeed in finding the way to integrate computers in to his existing teaching style" (ibid., p. 144).

By contrast, the French teacher used computers extensively and in a number of different ways. His main use was in ways which fitted with his existing teaching practice, but Veen observes that this experience

"gave him the opportunity to prepare himself for the use of CAL with more complex pedagogical settings, such as those involving group work [with which] he had very little experience." (ibid., p. 143).

Veen (1993) found that both school-level and teacher factors were important in the teachers' use of computers. School-level factors included the financial and moral support of the principal, and the day-to-day support of the technical assistant. However, the findings suggested that

"teacher factors outweighed the school factors in explaining the teachers' uses of computers" (ibid., p. 147).

Teacher factors included both skills and beliefs. Veen (1993) stresses that the skills that were most influential were those which

"related to their competence in managing classroom activities, to their pedagogical skills, and less importantly, to their computer-handling technical skills." (ibid., p. 147).

However, despite the importance of these skills, the most influential teacher factors were to do with their beliefs about the content matter and pedagogy of their subjects, classroom roles, appropriate classroom activities, and the nature of education. Veen found that these beliefs seemed to influence the teacher's skills more than vice versa, and observes that the teachers tried

"to fit information technology into pedagogical approaches consistent with their beliefs and their skills. Although three of the teachers also tried to enhance their skills, their beliefs were hardly changed by the influence of educational technology." (ibid., p. 147).

In common with Loveless (1996) Veen (1993) concludes that it is important that

"innovative activities [fit] into the existing beliefs and skills of teachers ... this

orientation might upset some advocates of information technology. However, only by acquiring positive experiences with computers in a way that teachers do appreciate, is there a chance that their newly developed skills will start to change their beliefs ... Perhaps it will be the only after two or three years that teachers can gradually enhance their routines and handle more complex applications of information technology" (ibid., p. 149).

The final paper in this section is by Kerr (1991), who also stresses the importance of considering individual perspectives on

"how teaching and the teacher's classroom role are conceived, what technology is 'good for' ... and how these elements do or do not come together in a vision of how 'teaching with technology' might look to a practising educator" (Kerr, 1991, p. 115).

Kerr (1991) suggests that some educational technologists are in danger of over-emphasising the importance of CBL⁴, and viewing the teacher as a

"classroom-based implementer of instructional strategies" (ibid., p.117).

Such a view, he says, denies recognition of the need for adaptability within the classroom setting and denies the role of educational establishments as places where significant "enculturation and socialization" (ibid., p. 119) occur. However, he also voices concerns that an over-emphasis on the craft and reflective aspects of a teacher's work results in a view of teaching which is so nebulous that rational planning of strategies becomes impossible. Additionally, while stressing the importance of classroom routines in enabling teachers to cope with multi-faceted classroom life, he also points out that

⁴ This over-emphasis can be seen in a number of studies on teachers and CAL. For example, Chin and Hortin (1993-94) in their literature review insist that "the capability of using technology is the most fundamental pre-requisite a teacher has to meet" (p. 89).

"classroom routine can become a barrier to productive teaching, and ... the press of trying to deal with large numbers of students at differing levels of achievement can hinder even the most creative teacher." (ibid., p. 120).

Kerr (1991) describes his findings from two studies; the first involved two sets of interviews and some observations with a group of 20 teachers, who were fairly casual users of technology; the second involved extensive investigations into the patterns of classroom organisation and interactions in six classes, where the teachers were taking place in a heavily technology-based programme. Kerr defines his research questions as follows:

- Can computers be useful tools for teachers who want to develop new classroom practices?
- What place does technology have in teachers' current thinking about the craft of teaching?
- How does classroom organisation and practice change in response to the incorporation of technology?

Kerr's (1991) findings revealed two visions of technology within teaching amongst his study participants. The first, which was evident throughout his case study group, saw technology as a "tool" or "lever", for example as something which is useful in dealing with administration and getting legible work from students. The second, which was particularly evident amongst the teachers on the technology-based programme, saw technology as a "fulcrum" for change. Many of these teachers mentioned the increased time they had for working with students on an individual basis, and the greater number of team projects and co-operative learning activities they had implemented. Some also mentioned an improvement in their classroom organisation.

Overall, Kerr notes that his technology-based teachers appeared to use computers in

order to encourage a more individualised feel within their classrooms; this is in line with the experiences of Sherwood's (1993) survey respondents (see Section 2.3). However, Kerr stresses that this interpretation requires caution because his study did not examine the extent to which the teachers were already inclined towards this emphasis before they started on the technology programme. Some of the interviews revealed that particular teachers

"had always preferred to structure classrooms flexibly, and that technology simply made that approach easier. Others, given the supportive environment ... obviously learned from those who turned their classrooms in this individualized direction" (ibid., p.132).

Finally, Kerr stresses, in line with Veen (1993) and Wild (1996), the slowness of the process of modification which accompanies learning about using new technologies.

In his group of extensive technology users this modification encompassed a

"measured development in their thinking about instruction, their role as teachers, and, most significantly, the look and feel of classrooms as the arenas where education takes place" (Kerr, 1991, p. 132).

In summary, the articles in this section indicate the following:

- departmental IT use is generally driven by individuals
- confidence in IT classroom use comes from within these individuals and their history of IT use
- these individuals may have mixed influences on their colleagues' use of computers
- initial users of technology are likely to use types of technology which fit with their classroom practice
- this practice is determined secondarily by school-level factors (e.g. support by technicians or the school principal) but primarily by the teacher's own teaching skills, and their beliefs about teaching and learning

- teachers may begin to experiment with their classroom practice as they become more comfortable with using the technology
- this experimentation takes considerable time.

The researchers reviewed in this section all stress the need for educational technology research to consider the complex and relatively inflexible nature of classroom practice. The following section describes a study by Brown and McIntyre (1993) that provides a framework which allows further examination of the nature of classroom practice and the response of such practice to classroom innovations; the study did not focus on classroom use of technology.

3.2.2 A framework for studying classroom practice

Brown and McIntyre's study (1993) aimed to explore how teachers organise their thoughts about their classroom practice by accessing their "professional craft knowledge", that is,

"knowledge and thought which teachers use in their day-to-day classroom teaching. Knowledge which is not generally made explicit by teachers and which teachers are not likely always to be conscious of using" (Brown and McIntyre, 1993, p. 19).

Their study involved a number of classroom observations and a series of follow-up interviews with 16 'good' primary and secondary teachers; the observations were audiotaped in order to stimulate recall, and the focus of the study was very much on the positive aspects of the observed session. A considerable portion of Brown and McIntyre's account is concerned with how they used information from pupils and colleagues in order to select a group of 'good' teachers.

The findings of this study suggest that teachers evaluate their teaching by reference to two short-term goals. The first and most significant of these goals involves setting up

and maintaining *Normal Desirable States of Pupil Activity* (NDS), which are steady states of activity that the teacher sees as appropriate for specific stages in the class. The second short-term goal concerns pupils' *Progress*, which relates to the coverage of work, the creation of products and cognitive or affective learning or development.

Brown and McIntyre note that

"while each teacher appears to depend in monitoring and evaluating lessons on a limited number of these two types of goal, each teacher seems to have a very large repertoire of *Actions* directed towards the attainment of these goals" (ibid., p. 68).

Unsurprisingly, the teachers also talked extensively about a number of *Conditions* which impinged on their teaching and influenced not only their actions, but also the standards they expected within the NDS and types of Progress. These conditions related to the lesson content (e.g. how demanding it was), the material conditions (e.g. equipment available), the characteristics of the teachers themselves (e.g. their states of mind), time (e.g. the amount of time available in the lesson) and, the condition referred to most extensively, pupils' characteristics (e.g. whether they were interested or bored, or whether they were normally disruptive or attentive). Brown and McIntyre suggest that the different concepts interact as shown in Figure 3.1. However they warn that this framework does not represent the fact that teachers tend to use a number of interwoven actions in pursuit of their goals, and that they often had to achieve some resolution between a number of conflicting goals.

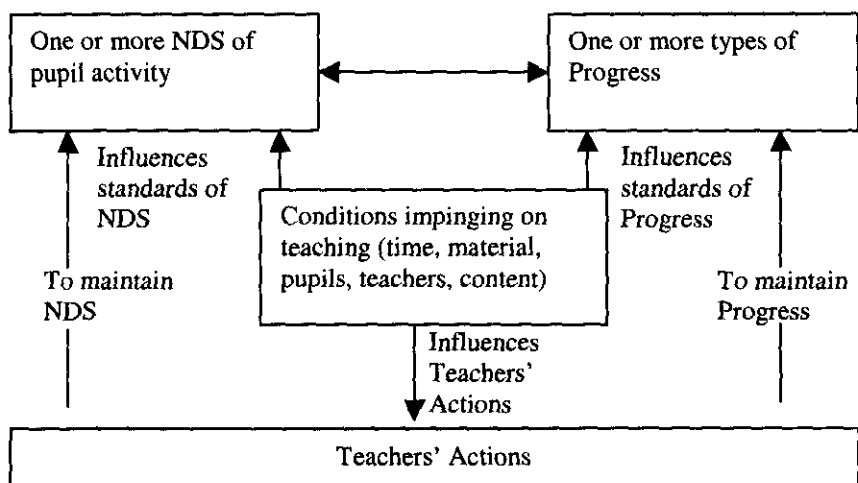


Figure 3.1 Interaction of concepts relating to classroom practice

(Brown and McIntyre, 1993, p.70)

Brown and McIntyre tentatively suggest that the framework might help to explain the poor uptake of educational innovations, primarily in terms of conflicting NDSs, and secondarily in terms of conflicting Conditions. They note that many such innovations are:

“concerned with pupils’ ways of working in classrooms, such as the nature of their talk, their practical activity, the sources of information they use, the ways they collaborate, the questions they seek to answer. Such innovations seek, in our terms, to define new ‘normal desirable states of pupil activity.’” (ibid., p. 116).

They emphasise the difficulty this causes when such an NDS is incompatible with the teachers’ and note that the innovation would have to prove itself far superior to established practices in order to justify

“the abandonment of the extensive repertoire of teacher tactics, and the even more extensive craft knowledge about when to use what tactics, that each teacher had built up over the years.” (ibid., p. 116)

However, it is important to stress that this framework is still under development, and that it does not imply that classroom innovations are inherently problematic. For example, subsequent work by Cooper and McIntyre (1996) uses the framework to study

incorporation of the National Curriculum (NC) in English and history departments.

This work suggests that in this case the innovation has proved generally positive, with the NC being

“an effective stimulus for collaborative planning and for the sharing of ideas among teachers” (Cooper and McIntyre, 1996, p. 160).

But Cooper and McIntyre (1996) also stress that this may be because the changes the NC requires are not so deep-seated in that

“adoption of the NC did not in itself directly require changes in classroom practice [but rather] extensions of existing repertoires” (ibid., p. 161).

3.3 Summary

The studies examined in Chapter Three indicate that beliefs about teaching and learning have considerable influence on teachers’ use of computers in the classroom. They suggest that many of these beliefs are shaped by the teacher’s own experiences in education, and that these experiences are, in turn, shaped by the way in which the educational system evolved in response to its initial mandates (Section 3.1). The studies described here propose that these beliefs are expressed in the ways in which the teachers interact with students, and structure their classrooms and classroom activities⁵. The teacher’s general classroom practice is then resistant to change primarily because of the resistance to change of the underlying beliefs (Section 3.2.1). However, classroom practice is also resistant to change because of the durable nature of the techniques which teachers develop in order to allow them to manage their classrooms fluently (Section 3.2.2).

⁵ This proposal is supported by a large number of studies relating teachers’ educational beliefs to their classroom practices (e.g. Kagan, 1992; Pajares, 1992).

The research suggests that some teachers may become more innovative in response to using classroom technology and/or that innovative teachers may find that classroom technology allows them to implement their preferred learning styles more easily. Teachers who use computers extensively in their teaching may be influenced in this by their computer-using colleagues, but the nature of this influence is complex (Section 3.2.1).

3.4 Conclusions

The studies described in Chapters Two and Three were used to identify a range of factors that needed to be considered in the thesis. It was noted in Section 2.4 that teachers appeared to face a number of barriers or hurdles when moving from being non-users of classroom computing technology to being extensive users who could integrate computers into their classroom practice; this journey is summarised in Figure 3.2. The representation of barriers/hurdles might imply a marked linearity; this would be misleading, and a more appropriate metaphor might be a highly convoluted and recursive obstacle course. Figure 3.2 is therefore referred to here, and throughout the rest of the thesis, as ‘the obstacle course’.

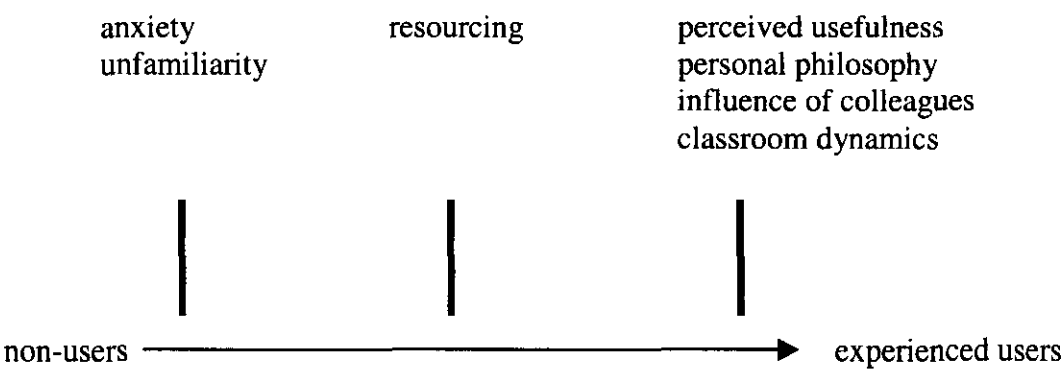


Figure 3.2 The obstacle course

It was suggested that the first of the obstacles was general anxiety about, and unfamiliarity with, computers (Section 2.2). The second major obstacle was seen as resourcing, and the importance of this obstacle was highlighted by most of the studies described in this review (Sections 2.2, 2.3, 3.1, 3.2). It was noted in Section 2.4 that resourcing concerns focused primarily on hardware, but that access to other resources was also important; these included software, technical support and co-ordination, staff development and increased time for teachers to develop their skills

Resourcing concerns are so wide-ranging that scattered pieces of the resourcing obstacle are likely to be found throughout the whole obstacle course. However, the final obstacle is the most convoluted of all. It includes interwoven aspects such as influence of colleagues, personal philosophies about teaching, learning, and computing, as well as issues to do with the individual's teaching style and classroom management (Sections 2.2, 3.1, 3.2); these last two are described here under the umbrella term 'classroom dynamics'.

The thesis investigated how the factors on the obstacle course interacted to influence CAL use amongst a group of FE biology teachers, and to explore how these teachers could navigate the obstacle course to become experienced/extensive users of CAL. Two externally derived frameworks were used in this exploration; classroom dynamics were investigated using the framework from Brown and McIntyre (1993) which was described in Section 3.3.2, and personal philosophies of education were investigated using a framework from Prosser, Trigwell and Taylor (1994), which is described in Section 5.5.1.

There is one factor that was highlighted by Becker (1993) (see Section 2.3) which does not appear on the obstacle course; this is gender. Gender issues were excluded

from the research in this thesis for two main reasons. First, and most obviously, gender is not something that is subject to change on the journey from non-user to experienced user of CAL. Second, and most importantly, it was felt that gender issues and CAL needed to be explored as the *primary* focus of a major study, rather than as just one amongst a set of variables, it was therefore decided that gender issues were outside the scope of the thesis.

Finally, there are a number of studies that have not been described in Chapters Two and Three which indicate the importance of 'higher' factors in determining uptake of innovations. For example: Huberman and Miles (1984) record the importance of school variables such as demographics and organisational rules and practices; Fullan (1982) stresses the importance of characteristics at the Local Education Authority level, such as board and community support, and at the school principal level; Plomp et al (1990) found that school policy considerations were also important; the FEFC (1998) found that the 'vision' of college principals had a considerable impact. However, as noted in the introduction to Chapter Two, the focus in this thesis was at the 'teacher level', and these 'higher' considerations were outside its scope.

The next chapter describes the first stage in the thesis field work.

Chapter Four: Survey of FE Biology Teachers

The first step in the thesis field work was to carry out a survey. The aims of the survey were twofold. The first aim was to identify individuals who would be prepared to be involved in further research. The second aim was to build up a general picture of how a group of UK FE biology teachers were using computers, and, through this, to begin to explore the nature of some of the factors on the obstacle course. The main research questions underlying the survey were as follows:

1. How computer literate is this group of FE biology teachers?
2. Are the teachers enthusiastic about the use of technology in education?
3. How much use are they making of CAL?
4. Does their computer literacy relate to their use of CAL?
5. Do their attitudes towards technology affect their use of it?
6. Does their length of teaching experience affect their CAL use?
7. Does their previous use of computers affect their CAL use?

This chapter describes the questionnaire design, distribution and findings. The organisation of the chapter is as follows:

Section 4.1 *Questionnaire structure*. This section describes the overall design of the draft and final questionnaires.

Section 4.2 *Questionnaire distribution*. This section describes sampling decisions and the distribution of both the draft and final questionnaires.

Section 4.3 *Survey findings*. Here the patterns evident in the survey responses are described and discussed.

Section 4.4 *Conclusions*. This section addresses the research questions listed above in the light of the findings.

4.1 Questionnaire structure

Two questionnaires were designed and distributed, a draft questionnaire and a final questionnaire. Responses to the draft questionnaire were used to produce the modified final questionnaire, which is shown in Appendix One.

Both questionnaires were divided into two sections, as follows.

Section A general background

- gender
- number of years in teaching
- educational background i.e.
 - subject of degree
- access to computers in HE

Section B current use of and attitudes towards computers

- access to computers at work and home
- general familiarity with computers i.e.
 - training
 - variety of applications used
 - frequency of CAL use
- perceived usefulness of computers in education

Other aspects were investigated that did not directly derive from the literature review. For example, Section A also included general questions about what specific subjects the respondents taught and what levels they taught in order to check the general homogeneity of the group. Section B also included a question asking the teachers to name any programs they used regularly. This was in order to try to build up a pool of suitable biological software which could be used during the Second Interviews. Other factors which were highlighted in the literature review, such as influence of colleagues and personal philosophies about teaching and learning, were judged to be better investigated by interviews. However, one open-ended question was included at the end of the questionnaire to access the respondents' general perception of the usefulness of

software; this asked whether the teacher was enthusiastic and/or optimistic about the use of computers in education.

The following measures were taken to increase the response rate:

- the questionnaire was designed to be brief
- the questions were generally designed for brief answers, or used check-boxes, so that they could be filled in rapidly
- personal questions about, for example, age or class of qualifications, were avoided as far as possible
- the covering letter stressed that the exercise was not intended to be judgmental, but that the responses might be useful in informing further research
- the questionnaire was anonymous, with identifying details (e.g. name, telephone number, workplace) only being asked for on a separate sheet for those who wished to become further involved in the study.

4.2 Questionnaire distribution

The project was registered under the Data Protection Act before the questionnaire was distributed. Contact with the respondents was mediated via college principals as questions were being asked about their work environment. The main decisions behind the sampling for the survey are described in Section 5.4, however, an outline is given here.

The main determinant for the survey group was that it should be made up of a number of FE biology teachers. As outlined in Chapter One, the research focused on FE biology in an acknowledgement that factors affecting biology teachers were likely to be different to those affecting teachers in subject areas where there was a different availability of software, and also to examine an under-researched sector.

Beyond this the sampling aimed to reach large enough numbers of biology teachers from a range of colleges to give findings which were generalisable to some degree and to ensure that these findings were not affected by highly localised conditions. The decision was made, in consultation with experienced researchers in the field, that the minimum number of respondents aimed for should be 50.

4.2.1 The trial questionnaire

The questionnaire was trialled on a small group of biology teachers at four London FE colleges; these biology teachers were all known to the researcher. The teachers were contacted before the trial and asked if they would be prepared to be involved, and, if so, whether they would highlight any difficulties they had when completing the questionnaire.

In December 1995 a copy of the questionnaire with a covering letter was sent to the principals of these four London FE colleges. The letter expressed the intention of sending the questionnaire to biology teachers at each college in January 1996 unless any objection was received. One principal objected and therefore in January 1996 copies of the questionnaire were sent to the individually named teachers at the remaining three colleges. Eleven completed questionnaires were received by early February. The analysis of these, plus informal feedback, was then used to modify the questionnaire in order to clarify some questions or to ask for further details in others.

4.2.2 The final questionnaire

A further 61 FE Colleges were identified from the Education Yearbook. These were mostly within 80 miles of London in order to identify a group which could be visited easily later in the research. Two copies of the questionnaire (plus pre-paid envelopes

and covering letters) were sent to the principal with a request that they be passed to biology teachers; a copy of the covering letter can be found in Appendix Two. A further two colleges declined to pass on the questionnaires to their staff. The final number of returns, by October 1996 was 68, and the analysis in the rest of this chapter is based on these.

4.3 Survey findings

The findings are described under a number of headings as follows:

4.3.1 General features of the respondent group

4.3.2 History of computer use

4.3.3 Work-based training

4.3.4 Access to computers and level of computer literacy

4.3.5 Computer use and attitudes towards computer use in education

4.3.6 More on general attitudes

4.3.1 General features of the respondent group

The gender of two of the respondents was not specified. Otherwise, 53 percent were female and 44 percent were male.¹ All respondents held degrees in biologically related areas such as zoology, botany, physiology, biosciences and earth sciences. The vast majority taught at NVQ levels 2 and 3 (approximately GCSE and A-level equivalent) with more at level 3 than at level 2. About 20 percent of respondents also taught at level 1 (entry level), and a different 20 percent at level 4 (degree level).

Their teaching experience ranged from one to 36 years. The breakdown of teaching

¹ This is broadly representative of FE teaching staff, where, of 278 000 teaching staff in 1996-97, 57 percent were female and 43 percent were male (FEFC, 1998b).

experience is shown in Figure 4.1.

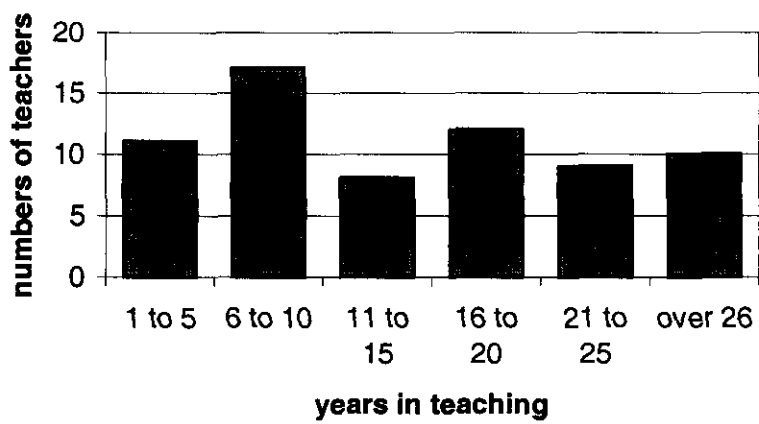


Figure 4.1 Breakdown of teaching experience in the survey group

There were fewer respondents than expected in the 1-5 years in teaching group. However, informal information from Garnett College (the only specialised FE teacher training institution in London, recently incorporated into the University of Greenwich) suggested that there was a drop in the number of biology teachers being trained from 1990 to 1996. This could account for lower numbers in the 1-5 years group, by comparison with the 6-10 years group². Approximately half the group (53%) had more than 15 years' teaching experience, and this division has been used extensively in the survey analysis.

4.3.2 History of computer use

The respondents were asked if they had used computers as part of their HE studies, and if so, in what context. Only 27 (41%) respondents had done so, primarily for data

² Data on length of service of FE staff are not available (FEFC, 1998b), so it is not possible to establish whether this is broadly representative of FE teaching staff.

analysis. Several had used programming applications, simulations, word processing, spreadsheets and tutorial programs. Some had used highly specialist applications, such as image analysis, and one had taken an MA module in computer pedagogy.

The majority of those who had used computers in HE had fewer than 15 years' teaching experience (see Figure 4.2). This is as would be expected because those who had *more* than 15 years' teaching experience would have completed their degree studies in the 1970s or earlier, when computers were used less extensively. However, it is not possible to be sure that the group with 15 or *fewer* years' experience necessarily completed their degree studies after this, because many people come into FE teaching as a second career³. This might go some way towards explaining why 36 percent of the group with 15 or fewer years' experience had no exposure to computers during their degree studies. Exposure to use of computers in HE appeared to have some bearing on the teachers' use of CAL and this is explored later in this chapter.

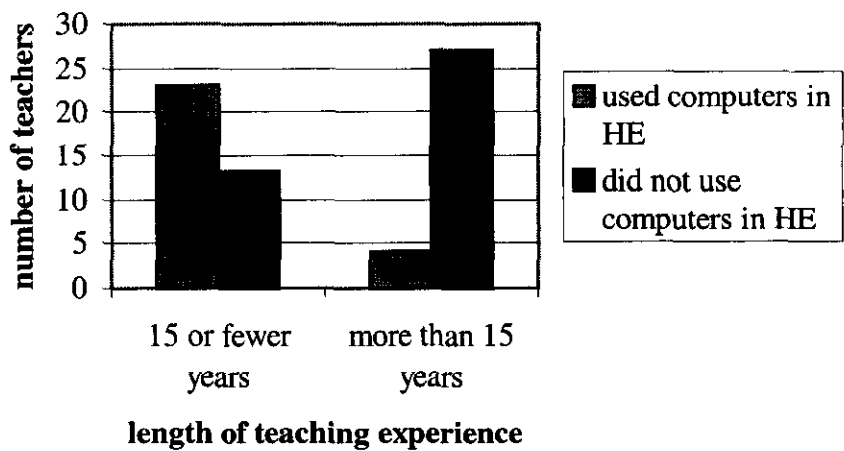


Figure 4.2 Number of years in teaching and previous exposure to the use of computers in HE

³ For example, the average age of the 1985-86 intake at Garnett College was 32.

4.3.3 *Work-based training*

Respondents were asked whether they had received work-based training in word processing, spread-sheets, CAL, or the use of "other" applications. Thirty one (46%) had had no training. The pattern was as follows:

Training	Total numbers of teachers
no training	31
word processing only	11
word processing and spread-sheets	12
CAL	8
any other combinations	6
<i>total</i>	68

This absence of work-based training amongst the teachers was in line with the findings from the literature (e.g. Sherwood, 1993) (see Section 2.3). Although the numbers were too small to draw any firm conclusions, the eight individuals who had had CAL training did not report making more use of CAL than those who had not had CAL training.

4.3.4 *Access to computers and level of computer literacy*

Sixty two (94%) respondents had daily access to a computer at work, and 53 (81%) had daily access to a computer at home. Home access emerged from the literature as being important with respect to CAL use (e.g. Downes, 1993) (see Section 2.2). However, the 15 individuals from the survey group who did not have access to computers at home did not report making less use of CAL than those who had such access. The numbers of respondents using various software/applications are shown in Table 4.1.

Table 4.1 Number of respondents using specific applications at home and at work

Application/software	Numbers of teachers using at work (out of the 62 with access)	Numbers of teachers using at home (out of the 53 with access)
Word processing	54	53
Spread sheets	30	0
CD-ROM	19	18
Statistics	16	10
Experimental control	14	0
Graphics	13	16
Electronic mail	7	7
Internet	6	7
Databases	4	4
Programming	4	3
Games	0	20
Desk-top publishing	0	1

Databases and desk-top publishing were not included on the original list, but were mentioned specifically by some respondents under "other", and they therefore may be more popular than these findings indicate. Several respondents indicated that they were using "other" applications, but did not specify what these were.

The number of different computer applications used by each respondent was taken in the survey analysis to indicate both the extent to which the respondents used computers, and their computer literacy. The assumption here is that an individual who uses, say, six different applications, can be said to use computers more extensively, and to be more computer literate, than an individual who uses, say, two applications.

Surveys which aim to gauge respondents' computer literacy often contain questions about the range of applications used; however, it is fair to say that where computer literacy is the main focus of the survey, there is also an assessment of the *type* of use the respondents make of each application (e.g. ITTE, 1998, see Appendix Three).

The mean and median number of computer applications used per respondent were calculated. This is shown below, along with the minimum and maximum values.

at home:	mean 3.1 applications median 3 applications [0-9]
at work:	mean 2.6 applications median 2 applications [0-7]
overall:	mean 3.7 applications median 4 applications [0-9]

The higher figure for overall use reflects the fact that the applications which were used at home were often different to those used at work. As can be seen, there was a disparity between home and work use. Higher use of computers at home emerges from a number of other studies, such as those looking at Open University computing courses, which reveal that, despite the absence of technical assistance,

"the convenience [of home use] is overwhelming" (Kirkwood and Kirkup, 1991, p. 204).

Overall the figures suggest that this group of FE biology teachers was making sufficient use of computers to equip them with the

"handful of basic skills [needed] to make effective use of computers in ... classrooms" (Wild, 1996, p. 137).

However, possession of these skills did not seem to have encouraged their use of

biology-based CAL in their teaching. A question asking the respondents how often they used biological CAL/CBL as part of their teaching yielded the following results

frequency of biological CAL use	percentage of respondent group (n = 68)
no use	46
rare or occasional use	29
monthly or more frequent use	25

In this classification respondents were recorded as making “occasional” use of CAL if they indicated that they used it at least once a term. They were recorded making “rare” use of CAL if they indicated that they used it less frequently.

Only two individuals used biological CAL more frequently than once a month; one used it twice a month, and another used it on a weekly basis. As can be seen, nearly half made no use of biological CAL. It was thought that this finding might have been distorted by difficulties in terminology, that is, the respondents may have used packages such as data analysis and experimental monitoring, but not included these under the umbrella term “biological CAL”. However, this was checked during the interviews (see Section 7.2) where it emerged that most of the interviewees had broad definitions of CAL which included the use of such applications. Another point is that the interviewees were not asked how much use they were making of *general* CAL as opposed to biological CAL. Therefore they could have been using packages such as word processing in their classes, but the survey would not have picked this up.

The lack of biological CAL use meant that very few individuals filled in the section where they were asked to name biological packages they found useful. This had repercussions for the selection of software for the Second Interviews, as described in

It was noted in Section 4.3.3 that those respondents who had had CAL training did not report making more use of CAL than those who had not. Similarly, no relationship was evident between computer literacy (as judged by the number of computer applications an individual used) and CAL use, see Table 4.2.

Table 4.2 CAL use and computer literacy

Frequency of biological CAL use	Mean number of computer applications used (with median shown in brackets) [and min-max]	
	<i>At home</i>	<i>At work</i>
No use	2.9 (2.5) [0-8]	2.3 (2.0) [0-7]
Rare or occasional use	2.9 (3.0) [1-6]	2.8 (2.5) [0-7]
Monthly or more frequent use	3.1 (2.0) [0-9]	2.6 (2.5) [1-6]

Table 4.2 shows that the most frequent users of CAL did not appear to be more computer literate than those who used CAL only rarely or occasionally. They had a higher mean score (3.1) for home uses, but this was distorted by one particularly enthusiastic home user, and the median (2.0) brought this score down. These findings are in line with literature (e.g. Downes, 1993; Wild, 1995) which suggests that extensive computing skills are not needed for, and do not necessarily lead to, increased use of CAL.

Only two factors emerged from the survey as having a possible impact on CAL use; the first of these was the number of years the respondent had been in teaching, and the second was whether they had been exposed to computers in HE. The survey

respondents who had been teaching for more than 15 years *appeared* to use CAL less frequently than those who had been in teaching for 15 years or fewer, as follows:

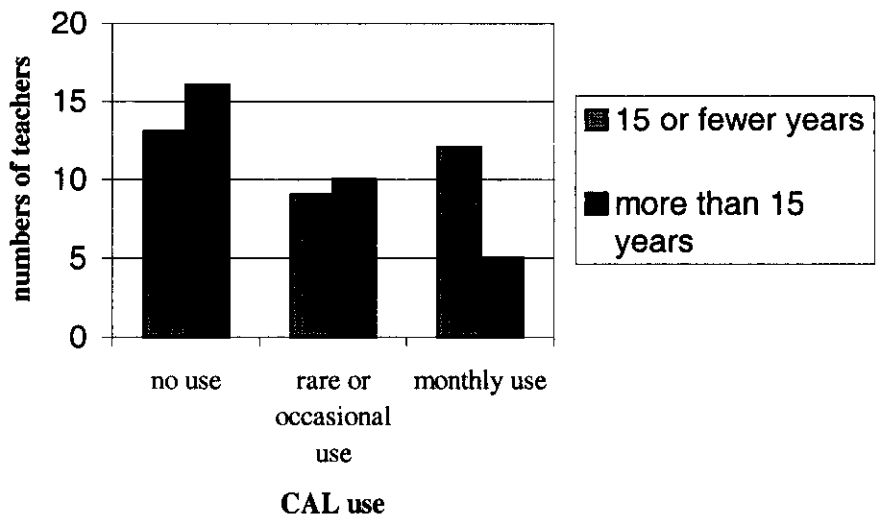


Figure 4.3 Current CAL use and teaching experience

However, statistical analysis of these findings gave a chi-square value of 3.12 at two degrees of freedom, therefore indicating that the difference in CAL use between the two groups was not significant. There was, however, a highly significant relationship between the respondents' previous exposure to the use of computers in HE and their current level of CAL use. This relationship is shown in Figure 4.4, which suggests that those who were exposed to the use of computers in HE made more use of CAL than those who were not. Analysis of these findings gave a chi-square value of 14.61 at two degrees of freedom, giving a significance of less than 0.01.

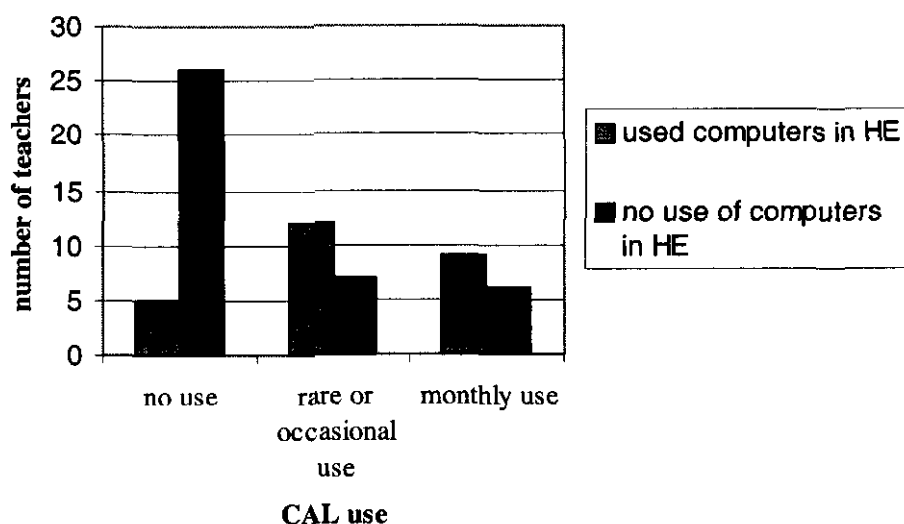


Figure 4.4 Current CAL use and previous exposure to computers in HE

As can be seen from Figure 4.4, the most striking aspect of this relationship was in the ‘no use’ category, which featured only five individuals who had used computers in HE, but 26 who had not. This finding appeared to accord with the findings of several of the studies discussed in the literature review (e.g. Downes, 1993; Becker, 1992; Kerr, 1991) which suggest that exposure to the practice of computer-using teachers is important for both pre- and in-service teachers’ development of classroom computer use. These studies focus on “current” exposure, but the findings here suggest that historical exposure (that is, when the teachers were still students) may also have been important. This would be in line with Cuban’s (1986) observation that an individual teacher’s practice is based to a large extent on the practice they experienced when they themselves were students.

Although not so striking, it appears that exposure to computers in HE may also have had some influence on general computer use at home and at work. This is shown in Table 4.3.

Table 4.3 Previous exposure to computers in HE and number of applications currently used at home and at work

Previous exposure to computers in HE	Mean number of applications used (with median shown in brackets) [and min-max]	
	<i>At home</i>	<i>at work</i>
used computers in HE	3.2 (3.0) [1-9]	3.1 (3.0) [0-7]
no use of computers in HE	2.9 (2.5) [0-7]	2.2 (2.0) [0-6]

The figures in Table 4.3 indicate that respondents who had been exposed to computers in HE used a similar number of applications both at home and at work. By contrast, respondents who had not been exposed to computers in HE used slightly fewer applications at work than at home. Again, this could be because those who had been exposed to computers as part of the educational workplace (that is, when they were students on a degree course) were fairly comfortable working with them under those circumstances. By contrast, those who had not been exposed to computers as part of their general learning programmes at HE might have felt more comfortable using computers less publicly.

The following section explores the respondents' attitudes to computers in education, and examines the relationships between attitude and use.

4.3.5 Computer use and attitude towards computer use in education

The information about the respondents' general attitudes towards computers in education came from their answers to the following question:

"Are you enthusiastic and/or optimistic about the use of computers within your teaching area? Could you give reasons for your answer?"

The responses to this question can be found in Appendix Four. Each response was placed into one of four categories, as follows:

- very positive** - if no negative comments were made
- positive** - if the tone of the answer was generally positive
- negative** - if the tone of the answer was generally negative
- very negative** - if no positive comments were made.

Categorising the answers was carried out by the researcher on three occasions, each at least two weeks apart. Although most of the answers were easily categorised, there were four which were problematic. Additionally, there were comments where the classification did not accurately reflect the degree of enthusiasm. For example:

"I look forward to the introduction of the internet facility"

was classified as 'very positive', but did not express the same level of enthusiasm as:

"I am both enthusiastic and optimistic, as the use of computers could open up opportunities for many students. However, the materials that would make good teaching materials are not yet widely available. Some interaction needs to occur between students and machine"

which was classified as 'positive'. The responses were subsequently classified by another researcher. This second classification produced the same result in 62 of the 68 cases, giving a 90% agreement.

Both of the researchers discounted two of the answers, as one was left blank and the other contained an essentially "don't know" answer. The remainder were classified as follows:

category	numbers of teachers
very positive	14
positive	43
negative	7
very negative	2
<i>total</i>	<i>66</i>

These generally positive attitudes towards the use of computers in education are in line

with the findings from the literature (e.g. Dupagne and Krendl, 1992).

It was noted in Section 4.3.4 that previous exposure to computers at HE had a considerable bearing on *use* of CAL. However, it did not appear to have the same bearing on *attitude* towards CAL, and there was a similar spread in both groups, as shown in Table 4.4.

Table 4.4 Attitude towards computers in education and previous exposure to computers in HE

Attitude towards computers in education	Number of teachers (n = 68)	
	<i>Used computers in HE</i>	<i>No computers used in HE</i>
very positive	6	8
positive	16	27
negative	3	4
very negative	2	0
unclear/blank	1	1
<i>total</i>	28	40

Cross-links were made in order to investigate the relationship between attitude, CAL use and extent of other computers uses at home and at work. In order to do this, mean CAL use was calculated as follows. First, the frequencies of CAL use were assigned a number:

- no use = 1
- rare or occasional use = 2
- monthly or more frequent use = 3.

Then the CAL use in each category was totalled and averaged. Application of numerical scores to non-numerical data is not ideal, but in this case it allowed comparison between the different levels of use in different groups. The findings are shown in Table 4.5.

Table 4.5 Attitude towards computers in education, frequency of CAL use and number of other computer applications used

Category	Number of teachers	Mean CAL use (and median)	Mean number of uses of other computer applications (and median) [min-max]	
			At home	At work
very positive	14	1.8 (2.0)	2.6 (2.0) [1-4]	3.3 (3.0) [1-7]
positive	43	1.9 (2.0)	3.2 (3.0) [1-9]	2.8 (3.0) [1-6]
negative	7	1.7 (2.0)	3.7 (2.0) [1-8]	3.2 (2.5) [2-7]
very negative	2	1.5 (1.5)	2.5 (2.5) [1-4]	1.5 (1.5) [1-2]

The small numbers in the negative and very negative categories mean that any conclusions drawn from the patterns shown here need to be very tempered, however, it appears as though the respondents' attitudes towards computers in education did not have a direct relationship with their frequency of CAL use. Once again, this is in line with the literature described in Chapters Two and Three (e.g. Hignite and Esternacht, 1992; Wild 1995, 1996). This finding may have been affected by the difficulty in considering something as complex as 'attitude towards computers' as a single variable (e.g. Hignite and Esternacht, 1992). It may also have some resonance with findings from a study by Collis (1985) on attitudes of female students towards computers. Collis (1985) found that the students in her study group felt that women were, in general, just as able as men when learning how to use a computer. However, the students also felt that they, *as individuals*, were *not* as able as men. Collis (1985) refers to this as the "‘We can, but I can’t’ paradox" (p. 213). It may be that the biology teachers in this survey were exhibiting something similar to this, that is, 'Computers are valuable in teaching, but not in mine'.

The findings, shown in Table 4.5, for mean number of uses of other computer applications do not reveal any clear pattern. This may reflect the inadequacy of using "number of applications" as an indication of the extent of the respondents' computer use and computer literacy. However, when considered in tandem with the literature reviewed in Chapters Two and Three, it seems more likely that the absence of a clear pattern reflects the complexity of the issues involved with computer use, and the problems of examining relationships between attitudes and use.

4.3.6 More on general attitudes

As noted in Section 4.3.5, the final question in the questionnaire was as follows:

"Are you enthusiastic and/or optimistic about the use of computers within your teaching area? Could you give reasons for your answer?"

The reasons the respondents gave were divided into two groups, positive and negative. Within these groups they were fragmented and further categorised in order to explore the focus of the positive and negative attitudes held by the respondents. The next two sub-sections address each group in turn.

Positive comments about computer use

The positive comments were primarily about how computers could be used as tools to enhance teaching/learning. This enhancement covered:

- a) increased versatility in handling the subject matter (e.g. experimental monitoring and information access)
- b) increased classroom variety and enjoyment.

Comparatively few comments also stressed that:

- c) computers were needed in order to respond to, and reflect, educational and social change.

Tables 4.6, 4.7 and 4.8 show the number of comments in each of these three categories,

along with illustrative quotes.

Table 4.6 Computers as teaching tools for handling subject matter

Categories	No. of comments	Examples (plus reference number for quote source in Appendix Four)
Data handling	12	"[I am] very enthusiastic. I am actively developing the use of computers for data capture/analysis and as a resource" (67)
Simulations	7	"[They allow] students to carry out 'experiments' which would otherwise be unethical"(3)
Information access	6	"More information is now becoming available on the internet, e.g.. gene web ... - there are also many other databases on line with relevant information and journal access is becoming more available" (12)
Experimental monitoring	5	"Love the logit [experimental monitoring system] - but only used for yoghurt and fermentations so far. Plan to use for environment. The chemists use it" (40)
Illustrating concepts	5	"IT is a valuable resource which enhances certain aspects in science which for many have been difficult to grasp." (25)
Problem solving	1	"The opportunity for providing interactive problem solving opportunities for students is enormous" (43)
<i>Total</i>	<i>36</i>	

Table 4.7 Computers as teaching tools for increasing variety and enjoyment

Categories	No. of comments	Examples (plus reference number for quote source in Appendix Four)
Increased variety of teaching styles	7	"I am very interested and excited by the prospect of using learning packages to add an extra dimension to teaching/explore new methods of teaching/learning" (57) "[Computers provide] a further mode of delivery + flexibility ... scope for student centred learning activities" (60)
Student enjoyment	6	"Very optimistic [about using computers] - students love to research and investigate using CD ROM leaving me almost redundant!" (50)
Teacher enjoyment	3	"Enthusiastic as I enjoy using them" (34)
Student confidence	1	"[They are] an excellent confidence builder for new adult Access students" (40)
Total	17	

Table 4.8 Computers as a means of responding to change

Categories	No. of comments	Examples (plus reference number for quote source in Appendix Four)
Reflecting work-based practices	6	"No doubt any late 20th C educational institution should be using computers in many ways" (59) "It is important to integrate IT into vocational education" (11)
Coping with reduced teaching time in Colleges	1	"With reduced teaching hours, self-learning packages based on interactive computer software could be invaluable" (38)
Attracting students onto courses	1	"If science teaching is to keep up to date and attractive to students then IT must be part of this equation." (25)
Total	8	

Specific applications were mentioned in a substantial number of responses, and these are shown in Table 4.9

Table 4.9 Specific applications seen as valuable by the survey group.

Categories	No. of comments	Examples (plus reference number for quote source in Appendix Four)
Word processing	13	"Very useful for students to be able to produce good assignments with graphics" (22) "[They have] revolutionised production of handouts, tests, assignments, homework, classlists etc. Word processor has changed my life far more than anything else to date" (40)
Simulations	7	"There are many packages available that simulate processes - animation etc." (25)
CD-ROM	6	"Cellular Pathology is a very visual subject and CD-ROM technology can be very useful for storage and retrieval and constructing interactive packages" (7)
Internet	2	"More information is now becoming available on the internet (e.g. gene web)..... – there are also many other databases on line with relevant information and journal access is becoming more available" (12)
Email and distance learning	2	"I also see E-mail becoming widely used in courses based on distance learning." (12)
Virtual reality	1	"It would be great to be able to 'walk' through a cell avoiding the nucleus watching the mRNA wizzing by - it would bring turgid areas of the subject alive" (24)
<i>Total</i>	<i>31</i>	

In summary, it was striking how far the comments were specifically tied to teaching biology. This was shown, for example, in the illustrative quotes in Table 4.6. It was also shown in the respondents' mention of specific applications. Word processing was the most frequently mentioned application, and this accorded with the fact that it was

also the application mostly widely used by the respondents (see Section 4.3.4).

However, the next most frequently mentioned applications were those which were seen as particularly appropriate for biology teaching (see Table 4.9), with its dependence on visual information and representations of multi-variable natural systems. Also striking was the sense of excitement about the use of computers that was evident in a number of comments, particularly those shown in Table 4.7. These contrasted with the comments in Table 4.8 which were less numerous, and reflected more practical concerns to do with *the need to use computers in order to respond to change*.

Negative comments about computer use

The negative comments were overwhelmingly concerned with resourcing, primarily hardware, and secondarily software (see Table 4.10). However, other concerns also surfaced, which were to do with:

- a) general pedagogical concerns about using computers in classrooms
- b) teachers' lack of time and training with respect to using CAL
- c) specific concerns about software quality.

Tables 4.10, 4.11, 4.12 and 4.13 show the number of comments in each of these four categories, along with illustrative quotes.

Table 4.10 Resourcing as a hindrance to the use of educational technology

Categories	No. of comments	Examples (plus reference number for quote source in Appendix Four)
General	29	"Little money available - would like to use packages far more but few available – computers are out of date in our department" (20)
Obsolete hardware	10	"Our only classroom computer in biology at an FE college is a BBC! ... and the mice inside are getting tired." (59) "Money has been spent on data collection boxes but college still to accept that modern computers are needed as well in order to run them." (9)
Cost of educational computing material	7	"Most of the packages I use are my personal property, i.e. paid for by myself and therefore only able to be installed on one machine at any one time because of copyright/prohibitive site licences." (29)
Funding arrangements in Colleges	3	"We have purchased data logging equipment ... but have now been waiting 6 months for approval from our finance people." (24)
Unreliable equipment	2	"I am very enthusiastic however my enthusiasm is constantly dampened by 'technical hitches' - network down/packages become out of date so quickly/printers don't work etc." (46) "Data logging has been disappointing. I can't rely on it to work every time." (33)
<i>Total</i>	<i>51</i>	

Table 4.11 Pedagogical concerns as a hindrance to the use of educational technology

Categories	No. of comments	Examples (plus reference number for quote source in Appendix Four)
Class size	6	"Only successful with <u>very</u> small groups" (61) "I enjoy using them...But they're best with small groups or individuals, and are they cost effective?" (34)
Too time-consuming for intensive courses	5	"Some packages I have seen take up too much time in an institution where many courses are only 1 year and if the syllabus is difficult to complete" (15)
Reduction of personal contact	2	"No I'm not [enthusiastic about computers] - when they are used instead of 'up the front' teaching and not to enhance it." (24)
Reduction of other, better methods	1	"In my heart of hearts I think pens and paper take a lot of beating." (40)
<i>Total</i>	<i>13</i>	

Table 4.12 Teachers' requirements as a hindrance to use of educational technology

Categories	No. of comments	Examples (plus reference number for quote source in Appendix Four)
Time	10	"[We need] time for staff to become familiar, confident and comfortable using this new technology in their teaching" (53)
Training	3	"Lack of training and resources ... makes me less optimistic than I might otherwise be" (36)
<i>Total</i>	<i>13</i>	

Table 4.13 Software quality as a hindrance to the use of educational technology

Sub-categories	No. of comments	Examples (plus reference number for quote source in Appendix Four)
General quality	6	"[I] have trialled several interactive biology packages for use by students over the years - none worth the time (so far)." (45)
CD-ROMs specifically	2	"Many CD Roms I have seen are just flashy pictures or amusing animations" (50) "The majority of CD-ROMs are still basically books on the screen." (21)
<i>Total</i>	8	

In summary, the respondents' main focus on hardware resourcing problems (Table 4.10) was in line with many studies on computer use amongst teachers (e.g. Dupagne and Krendl, 1992). Similarly, the pedagogical concerns about class size, software quality and reduced time for using better methods of teaching are also in line with the studies outlined in Chapters Two and Three (e.g. Becker, 1994; Cuban, 1986; Veen, 1993). However, the respondents' lack of focus on the need for training contrasts both with the research on teachers' computer use (e.g. Sherwood, 1993; Denk et al, 1993-94) and with policy recommendation documents (e.g. Higginson, 1996). This finding may reflect the fact that the respondents were primarily self-taught computer users (see Section 4.3.3) and explain why they focused more on the need for "time" than "training" (see Table 4.12).

4.4 Conclusions

The two broad aims of the survey were described at the beginning of this chapter. The first aim was to identify individuals who would be prepared to take part in further research, and out of the 68 survey respondents 34 indicated that they would be

interested in further involvement. The second aim was to build up a general picture of how a group of UK FE biology teachers were using computers, and, through this, to begin to explore the nature of some of the factors on the obstacle course. Seven research questions were outlined in order to frame this second aim, and these are now addressed in turn.

1. How computer literate is this group of FE biology teachers?

Computer literacy was judged according to the number of applications each individual used. The assumptions underlying this use were addressed in Section 4.3.4. According to this, most of the survey individuals appeared to use computers enough to provide them with, what Wild (1996) describes as the

"Handful of basic skills [needed] to make effective use of computers ... in classrooms" (p. 137).

2. Are the teachers enthusiastic about the use of technology in education?

The findings discussed in Section 4.3.5 suggested that the respondents were overwhelmingly positive about the use of computers in education, with 86 percent being categorised "positive" or "very positive" about such use. Although the respondents also expressed a number of concerns about educational use of computers (for example, in terms of resourcing), these were in line with concerns expressed by extensive CAL users in a number of other studies (see Section 4.3.6) and did not appear to indicate a general resistance to CAL use.

3. How much use are they making of CAL?

The findings described in Section 4.3.4 suggested that the respondents were making very little use of biological CAL; 46 percent made no use of it, and only two respondents used it more frequently than once a month. These findings may have been affected by difficulties with terminology (see Section 4.3.4), and this was checked

during the First Interviews.

4. Does their computer literacy relate to their use of CAL?

The findings outlined in Section 4.3.3 (see Table 4.2) suggested that there was no direct relationship between the respondents' general computer literacy and their use of CAL.

5. Do their attitudes towards technology affect their use of it?

Similarly, the findings outlined in Section 4.3.5 (see Table 4.5) suggested that there was no direct relationship between the respondents' attitudes towards educational technology and their CAL use. However, there were too few respondents in the "negative" and "very negative" categories to allow strong comparisons to be made with those in the "positive" and "very positive" categories.

6. Does their length of teaching experience affect their CAL use?

The findings from the survey suggested that there was not a statistically significant relationship between length of teaching experience and level of CAL use.

7. Does their previous use of computers affect their CAL use?

The findings discussed in Section 4.3.4 indicated that previous exposure to computers in HE had a strong relationship with current CAL use. Those who had not used computers in HE were far less likely to use CAL in their teaching.

In terms of the obstacle course (see Section 3.4) the findings on frequency of CAL use indicated that the vast majority of the respondents were some way from being "experienced/extensive" users of CAL. Most appeared to be past the first obstacle (general anxiety about, and unfamiliarity with, computers) in that they were using a variety of applications outside the classroom. Most also appeared to have a strong perception of the usefulness of computers in education (obstacle three) but viewed resourcing problems (obstacle two) as severely restricting their use. It was clear that

those who had not been exposed to computers in HE were experiencing more difficulties than the others in moving along the obstacle course; it was suggested (see Section 4.3.4) that HE exposure related to the factor “influence of colleagues” (see obstacle three).

The next chapter describes how the thesis interviews and classroom observations were designed to carry out further exploration of the factors from obstacles two and three.

Chapter Five: Methodology

This chapter examines the main features of the methodology employed in the construction and analysis of the interviews and classroom observations which made up most of the thesis field work. Its organisation is as follows:

Section 5.1 *Overview*. This section outlines the broad aims and structure of the field work in the light of the survey. It briefly indicates the nature of qualitative research and the importance of such research in the thesis.

Section 5.2 *The Researcher's Perspective*. This section examines aspects of the researcher's background which may have had bearing on the structure and analysis of the field work.

Section 5.3 *Bounding the study*. Here the range of the study is defined and the aspects which were studied and those which were not are identified.

Section 5.4 *Selection of the participant group (cross-case sampling)*. This section outlines the sampling techniques used in selecting participants for the interviews and observations.

Section 5.5 *Framing the study (within-case sampling)*. This section outlines the different aspects which were addressed during the interviews and observations.

Section 5.6 *Practical considerations*. This section describes some of the practical considerations which were borne in mind when planning both the setting up, and the running, of the interviews and observations.

Section 5.7 *Analysis*. Here the general analysis techniques used in the thesis are outlined.

Section 5.8 *Conclusions*. This section summarises the main features of the methodological approach.

5.1 Overview

The main aim of this thesis was to investigate the factors which appeared on the obstacle course (see Section 3.4) by examining how these factors interacted to influence CAL use in a number of teachers.

The survey was valuable in, firstly, providing a snapshot of computer use in a group of FE biology teachers, secondly, enabling initial explorations of some of the factors on the obstacle course, and thirdly, giving access to a subgroup which would be prepared to be involved in further research. Analysis of the survey revealed some information about the general computer literacy of the respondents, their overall enthusiasm for the use of computers in education, and the possible impact on CAL use of the respondents having been exposed to computer use in a previous educational setting. The level of general computer use amongst the respondents suggested they were mostly over the first obstacle (general anxiety about, or unfamiliarity with CAL) and therefore that this obstacle could be tentatively excluded from the subsequent investigations. The survey also revealed that the respondents felt resourcing issues were key in their use (or non-use) of CAL. The thesis field work was therefore designed to investigate the following main factors:

- resourcing
- the influence of colleagues
- perceived usefulness of CAL
- educational philosophies
- classroom dynamics.

The survey could not provide in-depth clarification of most of these factors, particularly those such as philosophies of learning and classroom dynamics. These factors had emerged in the literature primarily from in-depth studies conducted with relatively small numbers of individuals. In these specific studies the aim appeared to be

“to explicate the ways people in particular settings come to understand, account for, take action, and otherwise manage their day-to-day situations.” (Miles and Huberman, 1994, p. 7).

Such an aim is a key feature of qualitative research (Miles and Huberman, 1994) and it was realised when the thesis was being planned that these factors would have to be addressed using qualitative methods, such as interviews and observations, rather than quantitative methods, such as the survey.

It was thought that aspects such as resourcing, influence of colleagues and personal philosophies about teaching, learning and CAL would be best investigated using semi-structured, face-to-face interviews. These would allow the interviewer the flexibility to alter the questions in order to clarify them, and to clarify, or expand on, the answers. However, such a format would only permit a very generalised investigation of the interviewee’s views on the usefulness of software, in that it would not involve considerations of *specific* programs, and many of the prospective interviewees had already given a generalised view in their survey responses. Therefore it was decided that a second interview was needed, where the interviewee would be asked to look through software, giving their initial impressions, and talking about how, and if, they would use the software in the classroom.

This second interview would give a more concrete picture of the interviewee’s perceptions of the usefulness of specific CAL packages, but a very abstract view of how the software would relate to their classroom dynamics, in that it would be

decontextualised from classroom practice. Therefore it was decided that some classroom observations were also needed to see whether the interviewees' anticipated methods of using the software actually translated into action, and to investigate the role of classroom dynamics in influencing the teachers' use of CAL. The overall structure of the thesis field work therefore consisted of

- a survey, described in Chapter Four
- a pilot study which was used to trial the techniques for the main study interviews and observations, described in Chapter Six
- main study First Interviews, described in Chapter Seven
- main study Second Interviews, described in Chapter Eight
- main study observations, described in Chapter Nine.

Many authors writing on qualitative methodology (e.g. Mason, 1994; Miles and Huberman, 1994; Patton, 1990) stress the importance of combining different methods of study, noting, for example:

“Studies that use only one method are more vulnerable to errors linked to that particular method (e.g. loaded interview questions, biased or untrue responses) than studies that use multiple methods in which different types of data provide cross-data validity checks.”
(Patton, 1990, p. 188).

In this thesis the methodological triangulation was provided by the overall combination of quantitative (i.e. the survey) and qualitative methods, and the combination of different types of qualitative methods (i.e. the two interviews and the observations). This triangulation aimed to provide some of these validity checks.

5.2 The researcher's perspective

Authors who focus on qualitative research often stress the importance of stating the researcher's position, in an acknowledgement that the researcher is not simply a neutral

bystander. Kvale (1996), for example, emphasises that:

“an interview is really an *inter-view*, an interchange of the views between two persons, conversing about a theme of mutual interest.” (Kvale, 1996, p. 14).

Kvale (1996) suggests that data should be viewed as being not so much collected, but “co-authored”, especially in more open-ended investigations. This section therefore aims to outline the main features I brought to this research which may have influenced its direction.

I am an FE biology teacher with 12 years' experience, who has not managed to integrate CAL successfully into her teaching. I started this research because it seemed to me as though the reasons behind my lack of success were more complex than most staff development programmes tended to assume, and I felt this could well be the case for other teachers.

In terms of this research, my background had both positive and negative aspects. On the one hand my experience in this field should have given me a good level of understanding of the working circumstances and the subject area of the interviewees, and should also have worked towards increasing rapport, and therefore openness. On the other hand there was the danger that such a level of understanding could have resulted in the interview texts being less explicit, and some shared assumptions being unexamined. Additionally, it could have encouraged an undue emphasis on those cases which paralleled my experience, and an under playing of those which did not. Throughout the data collection and analysis this was borne in mind.

5.3 Bounding the study

Bounding the study involves defining the limits of its range. This is important in, for example, allowing decisions to be made about appropriate sampling (see Section 5.4)

and identifying limits on the types of generalisations that can be made from the research findings.

There are two broad approaches to bounding the study. One of these approaches is adopted by Miles and Huberman (1994). They stress the importance of defining the “case”, or “unit of analysis” (p. 25) and suggest that the definition of the boundary of the case is best served by a clear statement about what will *not* be studied. The second approach is adopted by Patton (1990). He also stresses the importance of defining the “case”, but suggests that:

“The key issue in selecting and making decisions about the appropriate unit of analysis is to decide what it is you want to be able to say something about at the end of the study.” (Patton, 1990, p. 168).

Both these approaches were used in planning the thesis field work, as follows.

This thesis aimed to say something about the factors which influenced individual teachers' decisions about using CAL in their teaching. Therefore its focus was two-fold; the main cases were the individual teachers, but the secondary cases were the factors themselves. Beyond this, a number of methodological and practical boundaries defined the scope of the thesis and determined what was *not* studied. These boundaries included:

- the style and findings of the studies informing the research (see Chapters Two and Three)
- the intention to aim for some degree of generalisability, and therefore the need to have a relatively large number of cases in the field work (see Section 5.4)
- the constraints that were consequently placed on the researcher's resources, particularly time.

As noted already, the secondary cases in the thesis were the individual factors on the obstacle course; it was in order to arrive at some broadly generalisable findings for these factors that the sample group had to be relatively large. It was noted in Section 3.4 that other 'higher level' factors, such as school policy or Education Authority support, might be important in determining CAL use amongst teachers, but it was stressed that the focus in the thesis, as in most of the research reviewed in Chapters Two and Three, was on 'teacher level' factors. It was also stressed that gender issues were outside the scope of the thesis research.

The primary cases were the individual teachers. The aspects influencing these individuals were explored from a personal perspective, that is, by looking at how these aspects were perceived by the teacher, rather than how they were perceived by the teacher's colleagues or the researcher. So for example, no interviews were carried out with the individual's colleagues, although the interviewees were asked about them. This type of perspective features strongly in some of the major studies which informed the research framework (e.g. Brown and McIntyre, 1993). It was also adopted here to allow a larger number of individuals (or 'cases') to be included in the research.

The thesis field work focused on the individual teachers at a specific stage in their work, rather than across time (although there were exceptions to this, introduced following the pilot study, see Section 6.7). Contact with some teachers was maintained over a number of months, but this was primarily a result of the difficulty in juggling syllabuses and timetables with interview dates, and was not a deliberate research policy. This research decision was influenced by a number of constraints, including the perceived difficulty in finding suitable cases for longitudinal studies.

Having defined the boundary of the case, it may be important to emphasise Miles

and Huberman's (1994) contention

“that the boundary is never quite solid as a rationalist might hope.” (p. 27).

Finally, as noted earlier, the definition of boundaries helps to define, and is defined by, the sampling used. Such sampling may be cross-case, which involves specifying the numbers and types of individuals to be involved in the study, or it may be within-case, which involves specifying the key factors (operating on each individual) to be studied, such as resourcing. The rationale behind the cross-case and within-case sampling used in the thesis field work is addressed in the following two sections.

5.4 Selection of the participant groups (cross-case sampling)

The participant group for the interviews and observations was a subgroup of the survey respondent group, and their selection was therefore determined by the selection process for the survey group itself; this was summarised in Section 4.2 but is given in more detail here.

The main determinant for the survey group was that it should be made up of a number of FE biology teachers. The research focused on FE biology in order to

- examine an under-researched sector (FE)
- acknowledge that factors affecting biology teachers are likely to be different to those affecting teachers in areas where there is a different availability of software
- achieve manageable results within the constraints of a three year thesis
- build on the researcher's strengths in terms of her knowledge of the curriculum and the operating systems within FE, particularly within biology.

Beyond this the sampling aimed to reach large enough numbers of biology teachers from a range of colleges to give findings which were generalisable to some degree, and to ensure that the findings were not affected by highly localised conditions (e.g. as

might be found in a sample which consisted just of inner London colleges).

The survey was sent to over 60 colleges, in order to get responses from teachers working in different colleges and in different regions. However, the range was constrained by access concerns, and therefore the colleges were all located within relatively easy reach of London (approximately 80 miles). The selection of the survey respondents was subject to a degree of 'gatekeeping' by the college principals who, in several cases, clearly directed the survey to their more computer literate staff. Additionally it may be significant that the respondents then made their own decisions about whether to respond; as such they were essentially self-selected and therefore could well have been more enthusiastic about computer use in education than the general FE biology population.

The interviewee/observation group was made up of survey group members who volunteered to be interviewed and/or observed; they were therefore doubly self-selected, and possibly even more enthusiastic about computer use than the survey respondent group as a whole. This was checked during the interview analysis (see Sections 7.2 and 9.2).

However, it is important to stress here that although representativeness was checked, it was not considered to be a primary driving force in the selection of the interviewee or observation groups. Patton (1990) describes the primary driving force *instead as a search for*

"information rich cases [i.e. those] from which one can learn a great deal about issues of central importance to the purpose of the research." (p. 169).

Miles and Huberman (1994) also stress that qualitative studies do not in general aim to produce "sample-to-population" generalisations (p. 28), for which true representativeness would be needed, but instead aim to produce

generalisations which will inform underlying theory. For example, these interviews were not being carried out in order to determine how far along the obstacle course FE biology teachers were in general, but rather to use individual cases to illuminate the interaction of factors on the obstacle course.

Discussions about generalisability are problematic in all research, but particularly in qualitative research where the sample groups are usually small. Patton (1990) suggests that it might be more useful to refer to “extrapolations” rather than “generalisations” when discussing the applicability of findings. He describes extrapolations as

“Modest speculations on the likely applicability of findings to other situations under similar, but not identical, conditions.” (Patton, 1990, p. 489).

The following two sections examine the rationale behind, firstly, the numbers of individuals, and, secondly, the “types” of individuals chosen for each part of the study.

How many?

This appears to be a very vexing question in qualitative research. Throughout the literature there is an emphasis on the ‘trade-off’ researchers are required to make. This trade-off is between carrying out in-depth studies with very few cases, at the risk of producing biased findings, and carrying out studies with larger numbers in order to add “*confidence* to findings”, but possibly at the risk of getting “thinner data” (Miles and Huberman 1994 pp. 29 and 30).

Seidman (1991), in common with other researchers (e.g. Strauss, 1967) uses two main criteria, sufficiency and saturation of information. He describes ‘sufficiency’ as meaning that there are sufficient numbers

“so that those outside the sample might have a chance to connect to the experiences of those

in it.” (Seidman, 1991, p. 45).

He describes ‘saturation of information’ as

“a point in the study at which the interviewer begins to hear the same information reported.” (ibid., p. 45).

Of these two criteria, the first was considered during the planning for this research, and the second was considered at stages during the field-work. However, the obvious point needs to be made here, which is that:

“the criteria of sufficiency and saturation are useful, but practical exigencies of time, money, and other resources also play a role, especially in doctoral research.” (ibid., p. 45).

Ultimately the decision was taken to interview 20 teachers in total, with the first six of these forming part of the pilot study. An initial decision was taken to carry out single observations with five of these 20, with the first three observations forming part of the pilot study. The numbers for the interviews and observations were decided on after consultation with individuals who were experienced in the field of qualitative research on educational technology. The proposed number for the observations was very tentative, with a final decision resting on, firstly, the outcome of the interviews, secondly, the numbers of teachers willing to be observed and, thirdly, the outcome of the initial observations. The final decision, made after the pilot study, was to observe six of these 20, and to observe three of these six twice; the reasons for this are given in Section 6.7.

Which types?

Patton (1990) describes a variety of purposeful sampling strategies that can be used in qualitative work. Those that appeared most relevant for the research described here were

- typical case sampling (in order to focus on the “norm”)

- maximum variation sampling (in order to test how far the developing underlying theory could encompass a diversity of cases)
- convenience sampling (in order to allow for speed and easy access).

Patton (1990) describes convenience sampling the least desirable, in that it lacks true purpose; but he also notes that it is probably the most common sampling strategy.

Over 30 of the survey respondents offered to be involved in further research. The final 20 who were interviewed were chosen on the basis of whether

a) they had offered to be observed as well as interviewed. Those who definitely did not want to be observed were considered as reserve interviewees

b) they were broadly representative of the survey group in terms of their computer literacy, their precise subject teaching area and their current CAL use, so that most of the interviewees lay in the middle range; this is typical case sampling. However, care was taken to contact individuals who lay outside the middle range (e.g. those who used the greatest number of computer applications, or those who taught on specialised course, such as pharmacology) so that the extremes were also represented in order to allow interesting aspects at both ends of the spectrum to emerge; this is maximum variation sampling

c) they could be contacted by telephone, and a mutually convenient time could be arranged; this is convenience sampling.

Literature on qualitative sampling (e.g. Patton, 1990; Miles and Huberman, 1994; Seidman, 1991) stresses the need for flexibility, so that the structure of a study can respond to emerging data. The selection of the interviewee group changed slightly after the pilot study. This was in response to the tentative finding that teachers who appeared to be reacting quite negatively to the software were very student-centred,

and that such teachers were under-represented in the pilot study group. Therefore, so that this aspect could be explored further in the main study, two biology teachers who were known to the researcher as being student-centred and articulate, but who had not been involved in the survey, were recruited into the interview group. These two were included with some reservations bearing in mind Seidman's (1991) observation that:

“the interviewers and the participants who are friends usually assume that they understand each other. Instead of exploring assumptions and seeking clarity about events and experiences, they tend to assume that they know what is being said.” (Seidman, 1991, p. 33).

Selection of the observation group was highly constrained by availability; there were two reasons for this. Firstly, despite having expressed a tentative willingness to be observed, some of the interviewees were ultimately not keen, and therefore withdrew. Secondly, many of the interviewees used software only a few times during the year, and once that particular part of the syllabus had passed they were unlikely to return to it for another 12 months. This meant it became very difficult to schedule appropriate times to observe them using software in their classes, and convenience sampling therefore played a considerable part here. However, following the pilot study it emerged that the research would be improved by the inclusion of observations with teachers who were using a broader range of computer applications than was first planned. Therefore efforts were made to include teachers who were using applications which were not represented in the Second Interviews (e.g. the Internet and experimental interfacing), and so maximum variation sampling also played a role in the observation group selection.

5.5 Framing the study (within-case sampling)

This section outlines the different aspects which were addressed during each individual

interview or observation, that is, the within-case sampling. It deals first with the two sets of interviews.

5.5.1 First Interviews

The aim of the First Interview was to investigate areas of the obstacle course such as influence of colleagues, ideal CAL and educational philosophies. It was also used to address issues which arose from the survey as needing further clarification, such as the respondents' meaning of the term CAL/CBL and their precise resourcing constraints.

It was envisaged that the interviewee's time would be a major constraining factor, and therefore the interview was framed so that it could be covered in an hour, but also so that it could be flexible enough to expand should more time be available. This approach constrained the structure of the interview so that, although it was semi-structured, it was also run within a fairly tight framework, so that the interviewer could cover a series of pre-determined questions. This constraint enabled cross-case comparisons to be made more easily.

The final version of the interview script started with the most straightforward questions, which were those to do with resourcing. It ended with the most complex questions, which were about the teachers' philosophies of teaching and learning (see d), below); these were derived from Prosser, Trigwell and Taylor's (1994) phenomenographic study, which is described overleaf. The interview script is shown in Appendix Five, but, in brief, the questions aimed to:

a) elicit information about the interviewees' precise working circumstances, for example: *If you wanted to use computers as part of one of your teaching sessions, what would you have to do?*

- b) give access to a personal perspective on occupational issues, for example: *Do you have any colleagues who are using computers as part of their teaching in a way which you think is effective?*
- c) establish the interviewee's view of software, for example: *What features would biological software have to have in order for you to want to use it in your teaching?*
- d) explore the interviewee's educational philosophies, for example: *What do you mean by teaching in the context of your work? What do you mean by learning? How would you know if a student had learnt something? How would the student know if they had learnt something?*

In all cases a degree of flexibility was maintained so that the questions could be altered or supplemented if required.

The Prosser, Trigwell and Taylor (1994) framework

This framework was included in the field work for two main reasons: the first was to provide a means of structuring and interpreting data on what was seen as a difficult area of investigation (conceptions of teaching and learning), and the second was to provide increased validity for the thesis by incorporating an external theoretical construct (see Section 5.7).

There is a wealth of research investigating individuals' educational concepts; this focuses mainly on students' conceptions of learning, or teachers' conceptions of teaching (Clark and Peterson, 1986). Amongst this research the Prosser et al (1994) study was chosen because, firstly, it focuses on teachers' conceptions of teaching *and* learning, and secondly, it situates these within a specific context which, while not identical to the FE biology context, is the closest that could be found amongst the literature on educational conceptions. The context in the Prosser et al (1994) study was first year

university chemistry and physics. This section will briefly outline the framework; a more complete account is given Chapters Six and Seven, where the framework is applied, and is illustrated with quotes from the First Interviews.

The aim of this phenomenographic study was to identify and describe conceptions of teaching and learning as held by first year physical science lecturers at two Australian universities. Prosser et al (1994) identified six conceptions of teaching (A to F) and five conceptions of learning (A to E) after interviewing 24 lecturers for between 45 and 60 minutes each. The conceptions ranged from very teacher-centred (A) to very student-centred (E or F). For example, teachers who were very teacher-centred focused on learning as the acquisition of information, and stressed that students would know they had learned if they could perform well (e.g. in examinations). By contrast, teachers who were very student-centred focused on learning as a development in their students' "world views ... of the subject matter" (ibid., p. 225), and suggested that:

"The students will know when they have learned something because it will have personal meaning for them." (ibid., p. 221).

Since, inevitably, their study participants expressed a range of conceptions during the interviews, Prosser et al (1994) classified them according to the *most* student-centred conceptions they expressed. Conception A was the most common classification amongst the interviewees, with nine of the 24 being classified as holding this conception for learning, and six being classified as holding this conception for teaching. There were three cases in the conceptions of learning, and six cases in the conceptions of teaching where the individuals could not be classified, because it was not possible to distinguish between two different categories.

5.5.2 Second Interviews

One of the aims of the First Interview was to investigate the interviewee's attitude towards biological CAL. However, as noted earlier, it was felt that this would give rather generalised information, and therefore the Second Interview was designed to give a more grounded perspective by asking the interviewees to look through and comment on specific packages.

It was decided that the individuals should be asked to look through three pieces of biological software they had chosen from a pool of 13. Details about how the pool was selected are given in Section 6.1. Three pieces of software were chosen because it was anticipated that, firstly, analysis of three reviews from each interviewee would allow identification of the interviewee's chief concerns, and secondly, it would be possible to review three programs within an hour, allowing approximately 15 minutes per program.

It was decided that during the Second Interview the interviewee would be asked to give their general impressions of the software and talk about whether and how they might use it in their teaching. It was anticipated that various problems might be encountered during the interview, which could affect the findings. For example,

a) different teachers were likely to have different skill levels with respect to CAL, therefore some would be more likely to ask for assistance from the interviewer than others

b) different packages might be very of different lengths and levels of complexity, therefore making it difficult for teachers to get a good sense of the more lengthy/complex packages in 15 minutes

c) some interviewees were bound to ask for recommendations about what they should view.

In response to these potential problems it was decided that the main feature of the Second Interview was to gauge individual teachers' attitudes towards whether they would use the software in the classroom, if so, how, and if, not why not. Therefore it was decided that in the interests of goodwill, and because it would not dramatically affect the main focus of the interview, any assistance would be given if it were asked for (for example, by somebody who was not particularly familiar with how to use software, or who wanted guidance as to which package might provide a particular feature) or if it were needed (for example, if somebody was getting lost, or if they could not find something they wanted to find).

5.5.3 Framing the Observations

The main aim of the observations was to observe teachers in their classrooms using specific pieces of CAL in order to explore how the use of software impacted on their classroom dynamics, and vice versa. The additional aims of the observations were

a) to see how far the teachers' projected use of software (as established from the Second Interviews) actually matched up to real use

b) to address aspects of the use of a wide variety of software, including applications that could not be included in the Second Interviews, such as the use of experimental interfacing and the Internet; the need for this emerged following the analysis of the pilot study (see Section 6.8).

To meet these aims it was decided that the teacher would be videotaped in the classroom while using software. As soon as possible after the observed session the tape should then be replayed to the teacher and they would be asked to comment on what was happening in the class, focusing on any aspects with which they were particularly

pleased or which they found problematic.

From early in the research a suitable framework was sought for, within which the observations could be both structured and analysed. As with the Prosser, Trigwell and Taylor (1994) framework, this was both to provide a means of addressing a difficult area, and to anchor the thesis observations to already established work in order to increase the validity of the findings. The framework chosen was from Brown and McIntyre's (1994) study on how effective teachers organise their thoughts about their classroom practice. The decision was made to use the Brown and McIntyre framework because, firstly, it suggested a means of framing teachers' difficulties in incorporating computer-based innovations into their classrooms, and secondly, the procedures and analysis were described in great detail and were therefore potentially replicable. The findings from Brown and McIntyre's (1993) study were described in Chapter Three, but the main methodological points are summarised here.

Brown and McIntyre's (1993) framework

In their study, Brown and McIntyre (1993) aimed to explore how teachers organised their thoughts about their classroom practice. In order to do so they studied 16 teachers (four primary and 12 secondary) who were considered as "good" by their pupils and peers. In the main part of the study they observed and audiotaped these teachers in their classrooms for two to six hours. Each observation was immediately followed by an interview. The teachers were then given the audiotapes to review, and were interviewed again about two weeks later. A third interview was carried out after the researchers had prepared selected extracts, based on the information from the first two interviews and pupil comments. During all the interviews the stress was very much on the positive aspects of the class, and the teachers were strongly encouraged to identify these and to

talk about what they had done to bring them about.

Following analysis of the transcripts Brown and McIntyre (1994) identified four key concepts which the teachers appeared to use in order to organise their thoughts while in the classroom; these were the Normal Desirable States Of Pupil Activity (NDS), Progress, Teachers' Actions, and Conditions. These four concepts were described in Chapter Three, and are illustrated in detail in Chapters Six and Nine, where they have been used in the thesis field work. Therefore they will not be described again here, other than to reiterate that Brown and McIntyre tentatively suggest that conflicting NDSs might be used to explain why many teachers find it difficult to incorporate innovations into their classrooms.

The Brown and McIntyre (1993) study was not directly replicable in this thesis for reasons of scale and focus, but the essential features were retained as far as possible.

For example:

- Brown and McIntyre observed their teachers for two to six hours, and followed up these observations with three interviews. It was not thought possible to ask the teachers involved here for such a level of commitment, and so an initial decision was made to observe five teachers for one hour each, and to follow this up with one interview (this interview is described from here on as the 'follow-up interview' or 'follow-up session'). After the pilot study analysis, this decision was revisited and it was decided that three teachers should be observed once, and three twice (see Section 6.8).
- Brown and McIntyre audiotaped the observed sessions and gave the tapes to the teachers so that they could review them before the Second Interview. Once again it was not thought possible to ask the teachers involved here for this level of

commitment. It was therefore decided that the sessions would be videotaped, and that the researcher and teacher should review the videotape together during the single follow-up interview.

- Finally, Brown and McIntyre's stress was very much on the positive aspects of the observed sessions, whereas the thesis observations needed to highlight any troublesome aspects. Therefore the teachers were asked to talk both about aspects with which they were particularly pleased, and aspects which they found problematic.

5.6 Practical Considerations

This section outlines some of the practical considerations that were borne in mind during both the setting up and running of the interviews and observations.

5.6.1 The two interviews

It was decided that the interviews would be best held in the interviewee's workplace.

This was primarily because the discussion was about work-related issues, and therefore the anticipation was that most of the interviews would naturally take place here. Where a choice of venues was offered, the workplace was chosen in order to aim for consistency.

All the interviewees were asked for their permission to record the interviews, and all were assured of anonymity.

As far as possible each interview was arranged for a time when the interviewee had at least an hour and a half to spare. Because of its relatively unstructured and interviewee-led structure, the Second Interview was viewed as being particularly difficult to manage in terms of time. In order to help the time management, and in order

to minimise researcher bias, the interviewees were asked to choose their three pieces of software before the interview took place. Other pieces were taken along to the interview in case time allowed the interviewee to look through more than three packages. The aim was also to have software loaded up on portable machines in order to minimise problems with installing software on unfamiliar systems present in the different colleges.

In the interests of good relations the interviewees were all informed of the reason for the research, and time was allowed at the beginning and end of each session for them to ask any questions. The interview began with the most straightforward questions (building on the answers to the survey) in order to help the interviewee feel at ease.

The basics of good interview practice were borne in mind during the process, for example avoiding asking leading questions or interrupting, asking for clarification where answers were ambiguous, listening for anecdotes as an indication of the validity of the account, and listening for shifts in the interviewee's position (Seidman, 1991; Kvale, 1996).

Finally, the researcher drew up summary sheets as soon as possible after each interview to capture impressions and nuances which might not have surfaced from the recordings.

5.6.2 The observations

The teachers involved in the observations identified a particular session where they would be using software in the classroom, and where they felt happy being observed. The software they used was either taken from the researcher's pool or belonged to their department. If it was from the researcher's pool then the software (and, where

necessary, the hardware) was given to the teacher at least three days before the observation.

The interviewees were told about the reasons behind the observations, and time was allowed at the beginning and end of each session for them to ask questions. As with the First and Second Interviews, they were asked for their permission to record the sessions, and all were assured of anonymity.

There were concerns about how far the presence of the researcher and/or the video would affect the observed session. To try to minimise this the video was set up in the most unobtrusive position possible, and the teacher was asked to introduce the researcher to the students, and explain why she was there. The main focus was on what the teacher was doing, and therefore the camera was principally used to track the teacher.

The follow-up interview was carried out as soon as possible after the observation. Once again the same basics of good interview practice were borne in mind and summary sheets were written as soon as possible after the session.

5.7 Analysis

This section outlines the broad analysis techniques which were used in the thesis. Most of the techniques were used extensively, however, this section includes references to just one or two parts of the thesis where each technique is evident.

Methods of qualitative data analysis have received increased attention over the last 20 years (Miles and Huberman, 1994). Such analysis can be variable, and its direction depends to a large extent on the ethos of the research (Yates, 1998). For example, research that is unstructured and uses theoretical constructs which are derived from the findings (e.g. grounded theory (Strauss, 1967)) requires a different form of

analysis from research that is more structured and uses pre-formed theoretical constructs. The nature of the analysis is also likely to be influenced by the preferences of the researcher. This observation reinforces the fact that qualitative data analysis is a flexible discipline, where

“There are no formulas for determining significance. There are no ways of perfectly replicating the researcher's analytical thought processes [and] there are no straightforward tests for reliability and validity.” (Patton, 1990, p.372)

and where

“The techniques of analysis are tools, useful for some purposes, relevant for some types of interviews, and suited for some researchers.” (Kvale, 1996, p. 187).

It was clear from the start of the field work that the details of the analysis would depend to a large degree on the style which was suitable for the particular research and the particular researcher, and that much of this was likely to evolve during the analysis itself.

The research in this thesis was fairly structured and used two externally derived theoretical constructs (Prosser et al, 1994; Brown and McIntyre, 1993). Where these constructs were used the researcher collected and analysed the data primarily according to the guidelines of their authors. Elsewhere the researcher used a variety of techniques to code, display, compare and interpret the data. Many of these techniques are described by Miles and Huberman (1994) in their sourcebook on qualitative research, and the following three sections address, in turn, what Miles and Huberman (1994) describe as the three concurrent activities involved in qualitative data analysis, namely, data reduction, display construction, and conclusion drawing and verification.¹

¹ It should be noted here that Miles and Huberman (1994) are enthusiastic about using computer systems to aid analysis, whether word processors or more dedicated packages.

5.7.1 Data reduction

The first step in the analysis of the interviews and observations involved the production of interview transcripts. The first ten interview transcripts and the first five observation transcripts were fully transcribed, so that they included pauses, hesitations and asides. The remainder were transcribed more selectively after the analysis themes had begun to emerge. The information in the transcripts was supplemented by notes which were written immediately after the interviews and during the observations.

Data reduction involves translating the transcripts into a form on which further analysis can be carried out. Patton (1990) suggests that the first step is to decide whether the initial analysis is going to be within-case or cross-case. If it is the former then the data need to be formed into case studies. If it is the latter then he suggests that answers from different individuals to the same questions need to be grouped together. In the thesis field work the initial analysis was cross-case (e.g. Section 7.3) so copies of the transcripts were made which gathered all the information on each variable (e.g. resourcing) together. Later analysis was within-case (e.g. Sections 8.6 and 9.4), so here the analysis was carried out on the transcripts in their original form. Throughout the analysis it was borne in mind that it was important to move backwards and forwards between the reduced transcripts and the original transcripts and tapes to ensure the data were not being considered outside their original context.

The data were then coded so that different themes and topics could begin to emerge. The researcher carried out re-coding on a number of occasions, and as she

Although word processing packages were used extensively, some trial work with the dedicated package NUD*IST indicated that its potential benefits were outweighed by the RSI problems of the researcher, therefore it was abandoned before the end of the pilot study.

developed familiarity with the data the codes became more sophisticated. This was in line with Miles and Huberman's (1994) account². They distinguish between three different levels of coding at progressively more complex levels; descriptive codes (which simply note what is there), interpretive codes (which begin to emerge as the researcher becomes more familiar with the text) and pattern codes, which "identify an emergent theme, configuration, or explanation" (ibid., p. 69).

Miles and Huberman (1994) suggest that the researcher might benefit from creating a provisional list of codes before the research begins. However they also note that more inductive researchers may not wish to do this and suggest caution because "data get well molded to the codes that represent them" (ibid., p. 58). A provisional list of codes was not used in the research described here because of the researcher's reluctance to anticipate the findings.

Check-coding was carried out on three occasions (see Sections 4.3.5, 7.6 and 8.3). This involved two, and in one case, three researchers coding independently to check for reliability. However, Miles and Huberman's warning that there can be over-reliance on check-coding was also borne in mind; they suggest this over-reliance can lead to the position where

"an interpretation is only reliable when it can be followed by everyone, a criterion that could lead to a trivialisation of the interpretations." (ibid., p. 181).

5.7.2 *Display*

Displays were used to organise and compare data, and to identify and test emerging patterns. The displays used most extensively were matrices (referred to in the thesis as

² And the accounts of others, e.g. Strauss, 1967

'tables'), which consist of rows and columns; these were particularly useful for cross-case analysis (e.g. see Table 7.12). However, networks, consisting of linked nodes were also used, and these were particularly useful in within-case analysis (e.g. see Figure 7.1).

Miles and Huberman (1994) are enthusiastic about displays, arguing that:

"You know what you display. Valid analysis requires, and is driven by, displays that are focused enough to permit a viewing of a full data set in the same location, and are arranged systematically to answer the research question at hand ... With extended text, there can easily be "selective stacking" of the data - even with good intentions. An organised display wards off this problem." (ibid., pp. 91/92).

However, authors on qualitative data analysis also countenance caution here, because there is considerable overlap between construction of displays and both data reduction and conclusion drawing. Therefore:

"It is easy for a matrix to begin to manipulate the data as the analyst is tempted to force the data into categories created by the cross-classification to fill out the matrix and make it work." (Patton, 1990, p. 412)

and

"The very existence of matrices can sometimes lead you to unjustified feelings of certainty about conclusions. Look at the raw data to guard against this." (Miles and Huberman, 1994, p. 243).

This potential for bias was borne in mind throughout the data analysis.

Patton (1990) particularly stresses the importance of ensuring that the categories have "internal homogeneity" (i.e. that the data within one category really belong together) and "external heterogeneity" (i.e. that the difference between the categories is clear and overlapping is not extensive). Issues to do with homogeneity and heterogeneity were considered during the analysis (see Section 8.3.1) and the researcher took care to move

“back and forth between the data and the classification system to verify the meaningfulness and accuracy of the categories and the placement of data in categories.” (Patton, 1990, p. 403).

5.7.3 *Conclusion drawing and verification*

Conclusion drawing involves comparisons of data and identifications of patterns, therefore, as noted in the previous two sections, it overlaps with decisions about data reduction and construction of displays. Miles and Huberman (1994) caution that:

“There is a substantial body of research on how people attribute causality and form judgements. The general finding, baldly put, is that most people are rotten scientists, relying heavily on pre-existing beliefs and making bias-ridden judgements.” (p. 262)

and

“people are meaning-finders, even in the most genuinely chaotic data sets [and] patterns need to be subjected to scepticism.” (ibid., p. 246).

They suggest that researchers need to check their ideas about emerging patterns, and subject their findings to tests of verification and validity; this section describes some of the checks used in the thesis analysis.

The basic pattern checks included:

- Clustering data into groups to see what fitted together (e.g. Table 7.9).
- Counting, “in order to see rapidly what you have in a large batch of data; to verify a hunch or hypothesis; and to keep yourself analytically honest” (Miles and Huberman, 1994, p. 253) (e.g. Table 8.5).
- Making contrasts/comparisons between the different aspects under study to firm up ideas about the relationships between them. (e.g. Section 9.4.4).
- Checking variables to ensure that, for example, what was registered as one variable was not in fact two or more (e.g. Section 6.5).

Miles and Huberman (1994) also suggest that researchers need a great deal of scepticism about apparent causal links, and that these should be subjected to validity checks. The types of validity check used in the thesis included:

- Considering that the apparent relationship ‘A causes B’, might be more like, ‘A and B are both caused by C’ or ‘A and B are caused by C and D respectively’ (e.g. Section 8.7).
- Searching for plausible alternative explanations as a valuable “exercise in self-discipline and hubris avoidance” (ibid., p. 274) (e.g. Sections 7.4, 8.7).

The thesis conclusions were built up gradually (as illustrated later in Figures 7.1, 7.2, 8.1 and 9.1) using both enumerative induction techniques (i.e. searches for instances which fitted in with, and therefore supported, the conclusions) and eliminative induction techniques (i.e. considerations of alternative explanations and searches for instances which did not fit with the conclusions, in order to define the limits of their applicability). The findings were also compared against those from other studies (e.g. Sections 7.8 and 9.5) to test their plausibility and therefore help to verify the conclusions.

Other types of verification included:

- Checking whether the events and individuals included in the study were broadly representative (e.g. Section 7.2) and being mindful of the possibility of ‘elite bias’ (i.e. overweighting evidence from striking events or articulate individuals).
- Making sure that the conclusions were tested against unusual cases (outliers), since “a good look at the exceptions, or the end of a distribution, can test and strengthen the basic finding” (ibid., p. 269) (e.g. Section 8.3.2 ‘information concerns’).

- Checking to see how far the researcher might have influenced the study, bearing in mind that “informers will often craft their responses to be amenable to the researcher and to protect their self-interests” (ibid., p. 265) (e.g. Section 7.4), and making sure measures were as unobtrusive as possible, and that study participants were as clear as possible about the researcher’s intentions (e.g. Section 5.6.2).
- Checking for triangulation to see how far independent measures of a finding agreed with each other. *These independent measures included: method triangulation, such as the combination qualitative and quantitative data, see Section 5.1; data source triangulation, such as the combination of data obtained from interviews and observations, e.g. Sections 7.6 and 8.4; researcher triangulation, such as the combination of findings obtained from independent researchers, e.g. Sections 4.3.5, 7.6 and 8.3; theory triangulation, that is, looking at the findings from different theoretical perspectives, e.g. Section 7.8.*
- Asking for participant feedback to see how far the findings made sense of the experiences of those involved in the study (this is another type of researcher triangulation) (e.g. Section 9.5).

5.8 Conclusions

This chapter aimed to show that issues to do with qualitative methodology had been considered throughout the thesis, from the planning of the field work and the data collection, through to the analysis and final presentation of the findings. The researcher’s perspective was outlined, and the decisions about cross-case and within-case selection were described and explained. Practical details behind the running of the interviews and observations were outlined (Chapters Six to Nine expand on these), as were key aspects of the two external frameworks used in the thesis (i.e. Brown and

McIntyre, 1993; Prosser et al, 1994). Finally, the broad analysis techniques were described; Chapters Six to Nine expand on the use of these techniques where it is felt such expansion is useful to the reader.

The next chapter describes how these research decisions were trialled in the pilot study before being applied to the main study.

Chapter Six: Pilot Study

The pilot study consisted of:

- a) First Interviews with six of the survey respondents
- b) Second Interviews with the same six
- c) Observations with three of these.

The study is described in this chapter under the following headings:

Section 6.1 *Setting up the pilot study*. This section describes the selection of the pilot study group and the selection of the software pool for the Second Interviews.

Section 6.2 *Profile of the pilot study group*. Here the pilot study group members are compared with the survey group members on the basis of their survey responses.

Section 6.3 *First Interview findings*. This section outlines the findings about the interviewees' resourcing, computer-using colleagues and ideas about teaching, learning and CAL.

Section 6.4 *Second Interview findings*. This section describes the interviewees' reviews of selected pieces of biological software.

Section 6.5 *Interview conclusions*. In this section the findings outlined in Sections 6.3 and 6.4 are considered in the light of the obstacle course.

Section 6.6 *Observation findings*. In this section the observation findings are discussed both generally, and using the Brown and MacIntyre (1993) framework.

Section 6.7 *Observation conclusions*. Here the observation findings are discussed and evaluated.

Section 6.8 *Overall conclusions and implications for the main study*. This section summarises the main findings of the pilot study and outlines the implications of these for the organisation and analysis of the main study.

6.1 Setting up the pilot study

This section contains two sub-sections. The first describes the selection of the pilot study group, and the second describes the selection of the software pool for the Second Interviews.

6.1.1 Selection of the pilot study group.

The overall selection procedure for the study participants was described in full in Section 5.4. All the survey respondents who indicated a willingness to be involved in further studies were sent a letter (see Appendix Six) in June 1996 which outlined the procedure for the interviews and gave details of the software pool. Because June, July, August and September coincide with the FE examination period, summer holidays and enrolment period, it was decided that the interviews should realistically start in October. The survey respondents were told they would be contacted from October 1996 onwards, but were asked to make direct contact themselves if they were prepared to be interviewed before then.

Three respondents were interviewed before October 1996. The first of these, Andrew¹, was known to the researcher, and was interviewed in May 1996 as an initial trial of the procedure. The other two, James and Bruce, made direct contact with the researcher and were interviewed over the summer. The other three respondents making

¹ All the respondent names have been changed for this thesis.

up the pilot study group, Maria, Jim and Pam, were the next three interviewees who indicated a willingness to be both interviewed *and* observed. Pam had also made direct contact over the summer, but a mutually convenient interview date could not be set up until after October 1996.

All six were interviewed twice, and four were observed; however, only the first three observations, those with Andrew, Jim and Pam, were analysed for the pilot study. The fourth observation, which involved Maria, was analysed as part of the main study.

6.1.2 Selection of the software pool

Thirteen pieces of biological software were gathered together for use in the Second Interviews. The criteria for software selection were as follows:

- Programs should be appropriate for use by biology teachers of, primarily, A-level/NVQ 3 and, secondarily, GCSE/NVQ 2, as these were the areas in which most of the survey respondents taught.
- They should be easy to demonstrate on a portable machine.
- They should be affordable by most biology departments. In practice this meant that programs of over £100 were normally ruled out, which was expedient both in terms of what most departments would normally buy, and in terms of costing the research.
- There should be a variety of IBM PC-compatible and Macintosh programs to cater for different systems which might be present in different colleges.
- There should be a variety of types of program (e.g. CD-ROMs, simulations, data interpretation programs, tutorials) in order to encompass different areas of interest, particularly those expressed in the survey responses.

The initial expectation was that building up the software pool would be fairly straightforward; in practice it was very problematical (Barnard, 1998a). The original intention was to select a range of currently used programs from the answers to the survey. However, in the event, only a few packages were being used (see Section 4.3.4), and most of these were BBC programs or programs where the suppliers could no longer be tracked down.

At that time there was no FE equivalent of the HE subject-specific information sources (such as CTI) and the centres that were contacted which were part of the LINK-IT network (which aimed to provide IT support for schools and colleges) were unable to help. In the end the best source of information was NCET who sent what they described as a “non-evaluative” list of 80 programs from their software database. Again, changing suppliers were a problem here, and over a quarter of the most promising programs listed came from a supplier (Legal Computers) who had been taken over by another company which decided to stop specialising in this level of program. Finance was another problem, with the other most promising set of programs coming from a publisher (Sheffield BioScience) whose IBM PC-compatible programs were only available on multi-user licenses at over £100 each.

Through the NCET software database, personal recommendations and recommendations in rare pieces of literature (e.g. Scaife and Wellington, 1993) 13 pieces of software were found which satisfied most of the criteria. One CD-ROM did not meet the cost and target level criteria. This was the *Biodiversity* CD-ROM, which was targeted at HE, and which would have cost over £500 for an FE department to buy (Trehwella, 1997). This was included on the basis of personal recommendation; it was provided free to the researcher and was used with the developers’ permission (the

Biodiversity Consortium at the University of Nottingham). It was used in the research because it was thought that it might provide an interesting contrast with the other packages.

Scaife and Wellington (1993) in their book on using IT in science and technology teaching, review a number of different ways of classifying software. The scheme which they found most useful derived from Kemmis, Atkin and Wright (1977) and classified software according to four different learning paradigms, that is, instructional, revelatory, conjectural and emancipatory, described below. Scaife and Wellington note that within this scheme the locus of control in the learner/software interaction shifted from the software (in the instructional paradigm) to the learner (in the emancipatory paradigm). They also note that more recent applications such as CD-ROMs were capable of incorporating all four paradigms. They summarise each paradigm as follows:

- *The instructional paradigm.* This is evident in drill and skill, or tutorial software, i.e. programs which concentrate on guiding the learner through specific content so that they cover pre-determined subject matter or exercise specific skills.
- *The revelatory paradigm.* This is evident in simulations, i.e. programs which deal with a specific subject matter, the underlying model of which is “discovered” by the learner as they use the program.
- *The conjectural paradigm.* This is evident in modelling software, i.e. programs which allow the learner to construct, modify and test their own models.
- *The emancipatory paradigm.* This is evident in labour-saving applications such as calculators, experimental interfacing and data analysis.

The survey responses indicated a general interest in software which fell under

all paradigms apart from the conjectural; only three respondents mentioned using modelling with their students (one of these, Mark, was observed using modelling software in his teaching, see Chapter Nine). This lack of stress on modelling software is in line with Scaife and Wellington's (1993) observations that

"The potential of model building and model testing has hardly been tapped in educational computing ... unfortunately the educational software to enable [students to create, use and test their own models is] likely to be time-consuming and expensive to produce." (p. 25).

None of the software pool fell within this category.

Emancipatory software was also under represented in the pool. There were three reasons for this. The first was that such packages are not easy to demonstrate on a portable computer in a limited time. The second was that most of the teachers already appeared to have adequate word-processing, database and spreadsheet packages. The third was that such software generally costs much more than £100. As a result of this only one "emancipatory" program, *StatView 4*, was included in the pool. However, the observations included two teachers using experimental interfacing and one using data analysis in their teaching (see Chapter Nine).

The remainder of this section briefly describes each of the 13 pieces of software, using the descriptions provided by the publishers in catalogues or in the software packaging. A fuller description can be found in Appendix Six.

Instructional programs

- *Plant Stacks*: animations, graphics and quizzes on botany
- *Darwin's Voyage of the Beagles*: animations, graphics and text showing Darwin's Voyage and outlining the key arguments around evolution

- *MacFrog Academic*: interactive dissection of a frog with explanatory text and quizzes
- *Mitosis and Meiosis*: animations, text and quizzes on cell division
- *A Tutorial in Recombinant DNA*: in-depth text with some animations and quizzes on DNA and genetic engineering
- *Swift-test*: a program allowing students to practice past A-level questions and receive feedback on their performance

Revelatory programs

- *Biological Simulations*: a set of four programs, originally developed for BBC computers, allowing students to simulate experiments on plant growth, metabolic rate, sampling methods and population genetics
- *SimEarth*: a complex program allowing the user to develop and modify planets in order to investigate aspects such as climate, biological diversity, energy and the effects of civilisations

Emancipatory programs

- *StatView 4*: an integrated statistics, graphics and report-writing package

CD-ROMs

- *The Ultimate Human Body*: a primarily instructional package using text, photographs, animations and cross-links to look at the cells, tissues, organs and systems in the human body
- *How Animals Move*: a package combining instructional and revelatory

paradigms which uses text, video, animations, interactive games and experiments to look at animal motion

- *Images of Biology*: a primarily instructional package designed to provide text, animation and images of animal cells and tissues in order to accompany a well known biology A-level text book
- *Biodiversity*: a very broad package combining instructional and revelatory paradigms, which was designed by various UK Universities under the Teaching and Learning Technology Program (TLTP) and aimed primarily at biology undergraduates

6.2 Profile of the pilot study group

Table 6.1 shows the details of the pilot study group, as given in their survey responses, and the dates of the interviews and observations. The pilot study group differed from the general survey group in the following ways:

- a) The pilot study group members showed slightly more home use of computers and slightly less work use of computers than the general survey group.
- b) They had a CAL use frequency as follows: 3 monthly: 3 none. The general survey group had a CAL use frequency of: 25% monthly: 29% rarely or occasionally: 46% none.
- c) None of the group was negative about CAL use, whereas 13% of the general survey group were "negative" or "very negative".
- d) They had a gender ratio of 4 male:2 female whereas the general survey group was almost 1:1.

Overall it was felt that the pilot group was not different enough from the general survey group to warrant concern about representativeness.

Table 6.1 Pilot study group details

	Andrew	James	Bruce	Maria	Jim	Pam
Location of college	London	Hants.	Beds.	Oxon.	Essex	London
Years in teaching	8	12	18	17	1	16
Previous exposure to computers in HE	✓	✓	×	×	✓	×
Access to computers at home (number of applications used)	✓ (1)	✓ (9)	✓ (4)	✓ (3)	✓ (2)	✓ (6)
Access to computer at work (number of applications used)	✓ (1)	✓ (1)	✓ (3)	✓ (2)	✓ (5)	×
Current level of CAL use	monthly	monthly	none	monthly	none	none*
Level of enthusiasm and/or optimism about CAL use	very positive	positive	very positive	positive	very positive	positive
Date of interviews	5 & 6/96	7/96	7/96	11/96	11/96	3/97
Date of observation	12/96				2/97	3/97

- ✓ = yes
- ×
- × = no
- * this changed shortly after the survey

6.3 First Interview findings

The First Interviews lasted between 45 and 75 minutes. One interview was conducted in the interviewee’s home; the others were conducted in the interviewees’ workplaces.

The format of the interviews was described in Section 5.5.1, practical

considerations in Section 5.6.1, and the broad analytical approach in Section 5.7. This section summarises and compares what the interviewees said about resourcing, their computer-using colleagues, their ideal software and their philosophies about teaching and learning.

6.3.1 Resourcing

When the interviewees were asked about resourcing, they focused on hardware. Issues to do with software resourcing emerged more strongly in response to the questions about their ideal software (see Section 6.3.3). Although there was considerable variation in hardware resourcing levels at the different colleges, there were several features in common.

Five of the six interviewees mentioned that most of the hardware resourcing went towards extensive centralised computer suites rather than classroom computers; this is in line with Loveless's (1996) observations about U.S. schools (see Section 3.1). Several of the interviewees commented, fairly mildly, on the inconvenience of this when they wanted to use a number of computers with their classes, primarily in terms of having to book the computer suites in advance, or being unable to book. However, two commented more strongly about the computer suites, one in terms of his resourcing:

"The students have a variety of computer suites all of which are, in my opinion, exceedingly badly resourced, um, not so much from a point of view of money, but more from the point of view of the people making the decisions ... what they're going for is the cheapest deals that look like the best ones to them - and then they don't know enough to be able to say that we could do better." (James²).

The other commented in terms of her classroom dynamics:

² James's previous career was in hardware specifications.

"We had a large computer suite ... but that's not useful for a biology class, because I feel you need to be in the classroom to teach with it." (Pam).

The contrast between computer suite resourcing and the normal teaching area resourcing was very marked. None of the interviewees had fixed computers in the laboratories where they normally taught, although Jim had access to a small room between his two biology laboratories which had four fixed computers. The other five interviewees had, generally, one computer on a trolley which was shared between several laboratories. In two cases the computer came from the teachers' staffroom and access to it for teaching purposes was difficult. For example, one teacher noted:

"[The students] are theoretically entitled to use our computer that's in our office, but, you know, that's not available to them really [and] if I decided that I wanted to run a lab perhaps where I was using computers I would have to make quite a palaver about doing it, but I'm sure I could do it " (James).

The laboratory computers were:

- for Andrew, a BBC
- for James and Bruce, 286s
- for Maria, a 286 and a 486
- for Jim, a group of 286s between the laboratories
- for Pam, a new Pentium.

The Pentium was acquired only after "considerable hard work and persuasion" (Pam). In general it appeared that unless the teachers invested considerable energy in trying to remedy the situation, college funds were directed towards centralised computer suite resourcing and the teaching area resourcing was very much a second priority.

The interviewees' perceptions of the adequacy of their resourcing were very

variable. Andrew, for example, saw his BBC as useful for classroom purposes. Bruce, by contrast, saw his 286 as incapable of running modern programs and therefore "useless".

6.3.2 *Influence of Colleagues*

Each interviewee was asked if any of his or her colleagues were using computers "effectively" as part of their teaching. No definition was given about what might constitute "effective" use.

Andrew, Jim and Maria had very little awareness of what their colleagues might be doing, while James, Pam and Bruce felt there was very little effective use. Pam and Bruce were the only two who gave reasons for this. Their reasons related to the perceived hindrances to computer use that emerged from the survey (Section 4.3.6). These included software availability, e.g.

"No [my colleagues are not using computers effectively]. Not because of lack of knowledge, but because it's difficult to get software which we like" (Bruce) and teachers' time, e.g.

"They haven't yet had a chance ...We have a situation where virtually all of my colleagues have got computers at home - a variety of types - and the ones who are computer literate at home are willing to give anything a go" (Pam).

In general it appeared that none of the interviewees were working in a "computer-use climate" (Downes, 1993) (see Section 2.2) where departmental use of biological CAL was a normal feature.

6.3.3 *Attitude towards software*

The interviewees were asked what features their ideal biological software might have. The answers revealed a similar division to the answers in the previous section. Andrew, Jim and Maria had no strong perspective on this, e.g.

"it's not something I've given a lot of thought to be honest." (Jim).

By contrast, Bruce, Pam and James had clearly thought about this issue before and had very clear requirements:

"So yeah, what my software has to be - it has to be structured, it has to take [the students] through a path of learning. If it's long it has to, stop and, you know, review that learning on a regular basis, and it has to be interactive." (James)

"A nice computer learning package would be to start at the beginning of the course and go through to the end of the course, referencing to text books, practical work and so on, but at the same time making sure the student has to dig for the facts and the information and to get the practice in applying the knowledge they had to analysing graphs and so on, to designing experiments etc. It would have to have tutor input, a lot of it, and interaction with other students and so on. " (Bruce)

"I think it would be great if we had a package with a video on it of where we go [on field trips ... and descriptions of techniques to be used, and plant identification packages] the sort of stuff we do every single year verbally, which would be better done on video, and bits where they could use the video, use the graphs, - you would be asked to suggest variables and there would be some feedback on whether this was a sensible variable ... That would be completely invaluable." (Pam).

There was a clear distinction between James and Bruce's ideas about software, which were fairly generalised, and Pam's ideas, which were far more concrete. It seemed as though Pam was focusing more on specific problem areas which she thought

could be addressed by appropriate CAL. According to Draper (1998) (see footnote 1, Section 2.3) this type of CAL would show "niche-based success", in that it would slot into an existing programme of work and overcome a "real pedagogic problem" (p.8). In the previous example Pam had identified a bottleneck where the pedagogic problem was that teachers spent a considerable amount of time going over routine material which could be delivered better using software.

Bruce and Pam were also quite vociferous about the absence of suitable software; there was a gulf between what they were looking for and what they had seen:

"So I think, really we're talking in terms of money - that's the big drawback, that's my first problem. Second problem is, simply, the software's not available ... a) there's not the software there ... b) it's inappropriate for teaching A-level, Access, GCSE syllabuses." (Pam)

"As regards using [CAL] in classrooms as a teaching resource, we need machines in the labs and we need a much more extensive range of software. At the moment I think the software is pretty good just as a library source, a reference source, not much more than that." (Bruce).

Interestingly James, Pam and Bruce all made contact with the researcher in order to try out the software and be interviewed over the summer (Section 6.1.1). In this respect they seemed to be very active in their search for good biology software. In James's case this may have reflected his general interest in computer use; his previous career was in hardware specification, and at the time of the survey he used more software applications than any other survey respondent. Pam and Bruce's search for suitable software, and their perspectives on their colleagues' use of computers may have reflected general interest, but may also have reflected their positions within their colleges as Science Co-ordinator and Head of Department respectively, and their sense of a need to

build CAL use into the profile of their areas of responsibility.

6.3.4 *Philosophies of teaching and learning*

The structure of the relevant questions for this section, and the interpretation of the answers were derived from Prosser, Trigwell and Taylor's (1994) framework. This framework was outlined in Section 5.5.1 and is applied here with illustrative quotes.

In their study Prosser et al outlined five conceptions of learning and six conceptions of teaching; these are summarised in Tables 6.2 and 6.3. Each table is followed by brief examples showing how the classification system was used in the pilot study. The six interviewees were classified and re-classified by the researcher on several occasions, until the classifications were constant.

Table 6.2 Conceptions of learning

Outcome of learning	Focus on learning as...	Conception
it satisfies external demands	accumulating more information/skills	A
	acquiring concepts and relations between them to extend prior knowledge	B
it satisfies internal demands	acquiring concepts and relations between them to extend prior knowledge	C
	a personal conceptual development	D
	a personal conceptual change	E

(adapted from Prosser, Trigwell and Taylor, 1994)

The classifications for learning range from teacher-centred (A) to more student-

centred (*E*). Within the scheme the individual teacher is classified according to the *most* student-centred ideas they express. So, for example, in the following quote Jim expressed the idea that learning was driven by external demands (i.e. the student knows they have learned something because they perform well in a test) and internal demands (i.e. the student knows they have learned something because such knowledge is intuitive); this meant that his classification for conceptions of learning would have been at least *C*:

How does the student know if they have learned something?

"Um, I don't know, I think probably again they'd be looking at their marks that they got back from homeworks, tests, that sort of thing. But I think you do know if you know something - it's quite a, sort of, intuitive thing" (Jim, final classification = *conception C*).

Only one of the six interviewees talked about learning as something which satisfied external demands:

How does the student know if they've learned something?

"They have their objectives at the beginning, so presumably they try to make sure they can do those things. And then at the end, they will be given assessments ... and they will see how they match up to their objectives ... It's as simple as that, so, very much assessment-linked objectives." (Pam, *conception B*).

The other five interviewees all expressed some sense of learning as satisfying internal demands. Four of them concentrated on learning as the acquisition of external concepts, e.g.

"[Learning is] being able to revise a section of knowledge," (Maria, *conception C*),

"[Learning is] adding to your general knowledge of facts and concepts [and] understanding how they all link together in a sort of broad overview." (Jim, *conception C*).

Only one of the six expressed the idea that learning was concerned with the

learner's personal conceptual development or change:

How would you know if a student had learned something?

"Usually the traditional way, tests and so on, also conversations as well. But feeling comes into it as well, although how you assess gut feeling I haven't got a clue, but their whole pattern changes, their approach changes as well." (Bruce, *conception E*).

Using the scheme,

- Pam's classification for learning was *B*
- Andrew, James, Maria and Jim's classifications for learning were *C*
- Bruce's classification for learning was *E*.

The classification for five of the interviewees was straightforward, but the researcher had problems in deciding on the most appropriate classification for Pam. Strictly according to the Prosser et al (1994) framework it was *B*. However, it seemed to the researcher that Pam had become side-tracked during her answers to the questions. She began by talking in a fairly student-centred way, but once she mentioned "learning objectives" she seemed to switch into a type of "teacher-speak" from which she did not emerge. The quote below shows when this happened:

How would you know if a student had learned something?

"By them being able to do something – so we're coming to the objectives, aren't we? I mean, [I'd use my lesson objectives to] see if they could indeed do the things which I'd thought they'd have been able to do at the end of the exercise ..."

...and how would you know if a student had learned something?

"They have their objectives at the beginning ..." (Pam, *conception B?*).

Pam was the only interviewee whose final classification was not consistent with the researcher's impression about an interviewee's degree of student- or teacher-centredness. Pam's classifications for both teaching and learning are therefore

recorded with queries in the remainder of this thesis.

Prosser et al's (1994) six conceptions of teaching also lie on a continuum from teacher-centred (*A*) to more student-centred (*F*), as shown in Table 6.3.

Table 6.3 Conceptions of Teaching

Prior knowledge	Focus of the teaching	How the teachers see their role	Conception
no focus on this	on concepts as outlined in the syllabus or textbook	as transmitters of information based on these concepts	A
	on the teacher's own concepts	as transmitters of information based on these concepts	B
focus on this	on concepts as outlined in the syllabus or textbook	as helping students to acquire these concepts and relations between them	C
	on the teacher's own concepts	as helping students to acquire these concepts and relations between them	D
	on students' world view or conceptions of the subject matter	as helping students develop their conceptions	E
	on students' world view or conceptions of the subject matter	as helping students change their conceptions	F

(adapted from Prosser, Trigwell and Taylor, 1994)

Conception *A* is characterised by an absence of focus on the students' prior knowledge, and by an emphasis on syllabus or textbook concepts, e.g.

What is learning?

"First of all that [the students have] got an understanding of what you're doing, the process that you're trying to ... get over ... it's understanding and acquiring skills"

... and what do you mean by teaching?

"If you're teaching A-level students their goal is to get a good grade in the exams and it's obviously getting a body of knowledge and also techniques that they've got to learn and an understanding of processes." (Maria, *conception A*).

More student-centred conceptions (*C, D, E* and *F*) stress the importance of prior knowledge, e.g.

What is learning?

"It's a pyramid type thing. You start off learning a whole load of fundamentals and gradually the depth of your knowledge gets greater, and your experience." (James, *conception C/D*)

and

"If you're going to learn successfully, you have to know what you don't know." (Pam, *conception C*).

With two of the interviewees, Andrew and James, it was not possible to determine whether their focus was on their own conceptions of the subject matter, or the concepts as outlined in the syllabus or textbook, therefore they were recorded as having *C/D* conceptions for teaching³.

The most student-centred conceptions (*E* and *F*) focus on the student's perspective and indicate that the teacher sees their role as helping students achieve their own "pattern changes [and] approach changes" (Bruce) rather than helping them to acquire external concepts, e.g.

³ This intermediate classification is not seen as problematic; Prosser et al (1994) recorded intermediate classifications for teaching in 6 of their 24 interviewees (Section 5.5.1).

What you mean by teaching?

"It encompasses everything to do with developing students' abilities and their understanding.... developing the skills which are there already, academic skills and organisational skills" (Bruce, *conception F*).

Using the scheme

- Maria was classified as holding conception A for teaching
- Jim and Pam were classified as holding conception C
- Andrew and James as holding conception C/D
- Bruce as holding conception F.

The overall classifications are shown below in Table 6.4

Table 6.4 Interviewee classifications for conceptions of learning and teaching

Teacher	Conception of learning	Conception of teaching
Maria	C	A
Pam	B?	C?
Jim	C	C
Andrew	C	C/D
James	C	C/D
Bruce	E	F

The relative absence of As and Bs in the classifications may reflect the fact that FE has, over the past few years, undergone considerable curricular changes, many of which are very student-centred. Any FE sample group is likely to be familiar with student-centred terminology, and this was borne out by the occasional comment, such as:

"What do I mean by teaching? Ah, I could give the usual, you know, facilitating learning." (James).

There was no obvious relationship between the interviewee's classification for teaching and learning and their frequency of CAL use, as gauged from the survey.

6.4 Second Interview findings

The Second Interviews were variable in length, ranging from approximately 45 to 120 minutes. The format of these interviews was described in Section 5.5.2, practical considerations in Section 5.6.1, and the broad analytical approach in Section 5.7.

During the Second Interviews the interviewees reviewed software they had previously chosen from the pool provided by the researcher (Section 6.1.2). The choice of software for the first three interviews was limited by which programs could be loaded onto the computers available during the interviews. By the last three interviews the software programs had all been loaded onto portable machines which the researcher took with her to the interviews.

Each interviewee looked through three pieces of software. They talked about whether they would use the software and gave reasons for this decision. In order to quantify the latter the researcher used the following scheme:

- Software which the interviewee would use in the classroom was rated **1**.
- Software which the interviewee would suggest students use in their own time was rated **2**.
- Software which the interviewee would not use at all was rated **3**.

Table 6.5 The pilot study group's ratings for the software they reviewed

Software	Used by	Rating
<i>How Animals Move</i> (CD-ROM)	Maria	1
	Jim	1
	Pam	1
<i>The Ultimate Human Body</i> (CD-ROM)	Andrew	1
	Jim	2
	Pam	2
<i>Images of Biology</i> (CD-ROM)	Andrew	1
	Bruce	3
	Maria	1
<i>Mitosis and Meiosis</i> (tutorial)	Andrew	1
	Bruce	3
	James	1
<i>Recombinant DNA</i> (tutorial)	Bruce	2
	James	1
<i>Darwin's Voyage</i> (tutorial)	James	2
<i>Swift-test</i> (tutorial)	Maria	2
<i>SimEarth</i> (simulation)	Jim	2
<i>Biodiversity</i> (CD-ROM)	Pam	3

In their survey responses the pilot group expressed enthusiasm about the use of computers in education. This enthusiasm appeared to hold when they were looking at specific programs, and 1 was the most common rating, given in nine out of 18 cases. Where interviewees said they would use the program in the classroom the range of reasons they gave fell under the following:

- a) simply because the subject and level were appropriate
- b) because the program contained large amount of accessible information with

good cross-links

c) because the program could do something better than traditional resources (e.g. perform simulations or show animations and video clips).

The focus of the pilot study analysis was more on why a particular piece of software would *not* be used in the classroom. Where the interviewees said they would use the program outside the classroom, or not use the program at all, the range of reasons they gave fell under the following:

- a) there were problematic resourcing issues
- b) the program did not fit in with time and syllabus constraints
- c) the program was not well structured
- d) the program showed no benefit over traditional resources
- e) the interviewee had concerns about the program's pedagogical foundations
- f) the program was generally inappropriate for classroom use.

Tables 6.6a) and 6.6b) summarise the reasons given by the interviewees to explain why they would not use a particular piece of software in the classroom. Table 6.6a) addresses their reasons for using the program outside, as opposed to inside, the classroom, and Table 6.6b) addresses their reasons for not using the program at all.

Table 6.6a) Interviewees' reasons for not using the program inside the classroom

Interviewee	Program	Reason for non-use	Illustrative quote
James	<i>Darwin's Voyage</i>	time constraints	"I'm enjoying sort of fossicking through it, but, you know, there's always finite time."
Maria	<i>Swift-test</i>	poor structuring	"Limited, limited use in this format...It's too inflexible."
Jim	<i>SimEarth</i>	time constraints and inappropriate for classroom use	"I don't think I'd use it in class. I think it's too complicated...I think it probably would be very effective, but I don't think it's a class-based tool."
Pam	<i>The Ultimate Human Body</i>	no benefit over traditional resources	"I just don't think it's stimulating - I don't think it does anything that you can't do yourself. That's really it. It's rather like a textbook, isn't it."
Bruce	<i>Recombinant DNA</i>	resourcing and inappropriate for classroom use	"To try to get students, for example, round one screen would be a joke and a half ... This would be something for students in their own time."

Table 6.6b) Interviewees' reasons for not using the program at all.

Interviewee	Program	Reason for non-use	Illustrative quote
Bruce	<i>Mitosis and Meiosis</i>	no benefit over traditional resources and pedagogical concerns	"It should also be stressing the biological significance more, all it's doing is giving a load of facts, not the overview and there's no scope for interaction at all...it's just like a moving text book."
Bruce	<i>Images of Biology</i>	no benefit over traditional resources and pedagogical concerns	"With biology nowadays, it's more the functional approach, this is more towards the histology side, just showing slides, which you could see far more effectively down microscopes."
Pam	<i>Biodiversity</i>	no benefit over traditional resources	"Again, so far nothing I couldn't say or do better by waving my hands around."

What clearly emerged from Tables 6.6a) and 6.6b) was the difference, again, between the group in general and Pam and Bruce. Jim, Maria and James each found one piece of software they said they would suggest the students use in their own time. They said they would not use this piece in the classroom largely because of time constraints or the program's limited flexibility. By contrast, Pam and Bruce completely discarded at least one of the three pieces of software, and their reasons centred on pedagogical concerns and the fact that they thought the programs showed no benefit over (or were actually less effective than) traditional resources.

Pam's objections accorded with the findings on her attitudes towards software (see Section 6.3.1). She wanted to see software which overcame specific problems within specific syllabus areas, and was therefore not keen on programs that simply did what she could already do.

Bruce's pedagogical concerns appeared to link with his philosophies of teaching and learning. He was classified as holding conceptions of teaching and learning which were different to those held by the other interviewees; he was also more negative about the software than the other interviewees, as shown in Table 6.7.

Table 6.7 Conceptions of teaching and learning, and software rating

Interviewee	Conception of learning	Conception of teaching	Rating of software
Andrew	C	C/D	1, 1, 1,
Bruce	E	F	2, 3, 3,
James	C	C/D	1, 1, 2,
Maria	C	A	1, 2, 1,
Jim	C	C	1, 1, 2,
Pam	B?	C?	1, 2, 3,

It may be that Bruce's view of the software was causally related to his philosophies of teaching and learning. It is possible that, in general, if there is a mismatch between the teacher's and the software's philosophies about education (or, strictly speaking the software *designer's* philosophies about education) then this could have a significant effect on the teacher's perception of the software's usefulness. It may also be that the other interviewees simply had less of a *focus* on pedagogical issues, which is why their conceptions lay in the middle range. If this is the case then it was not so much that their pedagogies *matched* the program's pedagogies, but just that this was less of an

obvious issue for them; they considered a program valid even if there was a mismatch.

6.5 Interview conclusions

The interviews gave more detail about the factors from the obstacle course, but they also reflected the complexity of the issues that were at work here. The survey revealed that the general respondent group was mostly over the first obstacle, which was general unfamiliarity and anxiety with computer use, but that issues such as resourcing, influence of colleagues, perceived usefulness of software and classroom dynamics were factors which needed to be explored further. The interviews yielded more information on all these areas, and this information was used to modify the obstacle course, as shown in Figure 6.1 (the links between the factors on the obstacle course are explained in the rest of this section). However, none of the interviewees had colleagues who were using computers in a way in which the interviewees would describe as "effective", and so, although this may have been mediating against the general take-up of CAL, it was difficult to assess its impact (hence the question marks on Figure 6.1)

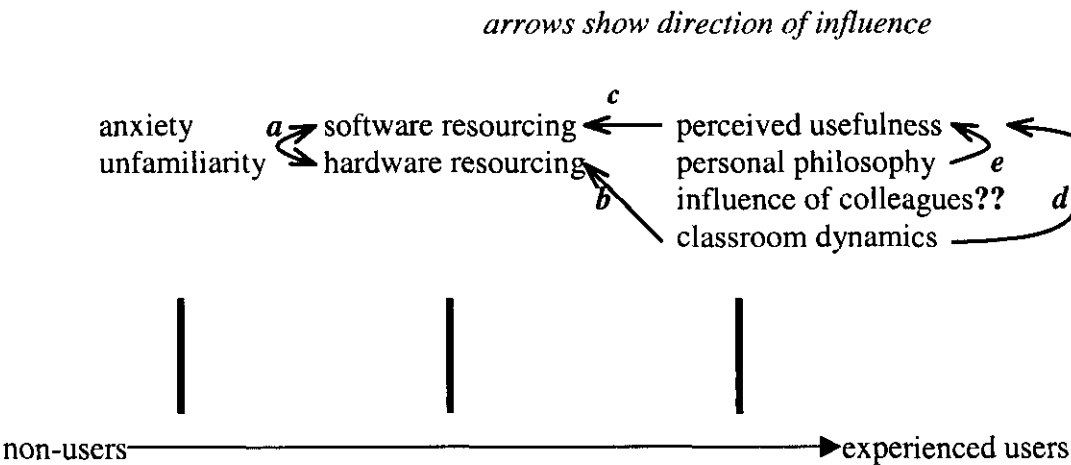


Figure 6.1 The modified obstacle course

The survey results gave some indication of the respondent group's problems with the second obstacle, that is, resourcing. The interviews revealed that the resourcing constraints were seen largely in terms of hardware, and that these constraints operated on a number of levels. At the most basic level, the absence of any hardware, or the absence of hardware sophisticated enough to run most programs was a major obstacle. Beyond this the level of hardware resourcing appeared to be variable with respect to the interviewees' perceptions of its effect. So, for example, Andrew had access to a BBC in the laboratory and was happy to use it. Andrew perceived his hardware resourcing as adequate because the BBC was able to run the software he wanted to use in the classroom. Bruce had access to a more advanced IBM PC-compatible 286 in the laboratories, but considered it so old that it was useless for his purposes as it was unable to run the PC programs he wanted to use. So in both cases the interviewees' perceptions of the adequacy of their hardware depended on the type of software they had access to (arrow *a* in Figure 6.1).

Bruce, apparently happily, used the computer suite with his students. By contrast, Pam considered computer suites to be incompatible with her teaching and had therefore made considerable efforts to improve laboratory resourcing. So it seems as though, in considering the impact of hardware resourcing, one also needs to consider the user's perceptions about the type of hardware resourcing they need in order to enable their teaching sessions to run effectively. Therefore hardware resourcing also appears to be influenced by the interviewees' classroom dynamics (arrow *b* in Figure 6.1).

Software resourcing issues appeared to operate at much more complex levels than hardware resourcing issues. The interviewees' perceptions of the adequacy of

their software resourcing rested not only on having sufficient funds to buy programs but also on having access to programs which would run on the available hardware (arrow *a*) and which were perceived as being potentially useful (arrow *c*). The "perceived usefulness" criterion depended on a number of other factors. For example:

- Andrew appeared to perceive software as potentially useful if it was in the right general subject area, at the right general level and did not offend his sense of pedagogy.
- Maria, Jim and James seemed to perceive software as potentially useful for the same reasons, but, additionally, they mentioned issues to do with classroom dynamics (arrow *d*): e.g., James saw class time as a problem, and Maria found one program insufficiently flexible to fit in with her class plans.
- Pam and Bruce had much more demanding views of software than the other four. They both insisted that it should be able to do something that conventional resources did not already do. Pam required that it fitted into a niche in the curriculum and Bruce also required that it matched his personal philosophies of teaching and learning (arrow *e*). Their software views may have been influenced by the fact that they had not had previous exposure to computers in HE; the relationship between HE exposure and attitude towards software is explored in the main study (see Chapter Eight).

The findings at this stage had begun to illustrate some of the recursiveness of the obstacle course. They also suggested that classroom dynamics had a strong impact on other factors from the obstacle course and it is this impact which is explored in the next section.

6.6 Observation findings

The format of the observations was described in Section 5.5.3 and practical considerations were outlined in Section 5.6.2. There were two approaches to the analysis of the observations. The first approach broadly followed the guidelines in Section 5.7 without using any externally derived theoretical framework. The second approach followed, as far as possible, the guidelines used by Brown and McIntyre (1993) in the development of their framework (Section 5.5.3). The findings deriving from these two approaches are detailed in Sections 6.6.1 and 6.6.2 respectively.

Three of the pilot study group members, Andrew, Jim and Pam, were observed while using software in their classes. In all three cases the software they chose for the observation came from the pool built up by the researcher for the Second Interviews. At least one hour of each class was videotaped, and the tape was re-played to the teachers as soon as possible; for Jim this was immediately after the class, for Pam it was three days later and for Andrew two weeks later. During the replay the teachers were asked to talk generally about what was happening, what they were doing, what the students were doing, what aspects of the session they thought went well, what aspects they found problematic, and generally whatever else occurred to them. The analyses of the observations were based on the recordings and transcripts of these comments, and on the researcher's own observations.

6.6.1 General findings

This section outlines the main features of the observed sessions and explores how the teachers talked about them.

Main features

All three teachers chose roughly similar classes to be observed: Jim and Andrew's classes were strikingly similar, Pam's had some key differences. The main organisational features of the observed sessions were as follows:

- a) The classes were at NVQ level 3; Pam chose a second year A-level group, Jim chose a one year degree foundation group, and Andrew chose a one year Access group.

Therefore most of these students were planning to go on to HE the following year. Jim and Andrew's classes were made up of mature students, ranging in age from twenties to forties. Pam's class was younger, ranging from late teens to late twenties. The number of students in each group was as follows:

Andrew's class:	15
Jim's class:	11
Pam's class:	16

- b) Jim and Andrew chose a class which was at the end of a topic session; Jim had just finished teaching movement, Andrew had just finished teaching cell division. Pam, by contrast, chose a mid-topic session; she was in the middle of teaching movement. Each of the teachers used a piece of software which they had come across during the second interview. Andrew used the tutorial on *Mitosis and Meiosis* (cell division), Jim used the CD-ROM *The Ultimate Human Body*, and Pam used the CD-ROM *How Animals Move*.

- c) All three chose two hour classes that incorporated a 20 minute break; such classes are fairly standard for A-level or equivalent. Both Jim and Andrew organised their 2 hours along similar lines. They had a first hour which consisted of the teacher inputting new theory at the front of the class, followed by a short break. They then had a second hour during which the students worked in three groups and rotated to three

different activities, spending approximately 15 minutes on each.

Pam only carried out teacher input with the whole class for the first 10 minutes. This was done in order to organise the class, rather than to deliver new theory. The class was then split into four groups which rotated to four different activities with each group spending about 20 minutes on each activity. This then gave 10 minutes for a concluding session.

Would the teachers use the program again?

All three teachers said they would use their program again. Both Jim and Andrew said they would use it in the same way, although Andrew mentioned that he would have liked to shorten the first part of the class so that there would be slightly more time for the computer work. By contrast, Pam suggested a number of major modifications to the way in which she would use the program in future, as follows:

"I would say this CD is available to all of you on this access system during the week, so they would hopefully go and play during the week, and then at the beginning of the next lesson, bearing in mind I've got some lazy students who would no way go and look at anything, I would put it on as my review, so I would take them through that again, focusing on the difficult points ... I would not use [it] to teach muscles. But then - would I come back to it in the lesson? I think at the end, ... - the contraction of muscle to produce the graph, just at the end. So I probably would run it for 10 minutes in the 2 hour lesson."

Reasoning behind the classroom activities

This section looks more closely at the different small-group classroom activities in the light of how the teachers described these activities during the follow-up session while they were watching the video.

Andrew

Andrew had three activities set up during the second half of the class. He had just finished covering cell division, and he was aiming to use this session to reinforce the theory that he had already covered. The activities he was using were as follows:

a) One group was using microscopes on an individual basis in order to try to identify different stages of cell division in plant and animal tissue. The aim of this was to

“look at the stages of *Mitosis and Meiosis* as they really appear, rather than the slightly stylised diagrams we tend to look at ... ideally, of course, it would be nice to draw them, but we're kind of short of time.”

b) Another group was using bioviewers on an individual basis. Bioviewers are essentially modified microscopes which an individual can use to look at annotated photographs of microscopic preparations. Andrew noted:

“What's good about these pictures is you've got specific notes to go with them. Which again, they might pick up additional information [from]. Or it might help their understanding, if they, you know, if they've been not sure of any particular part. It gives them an opportunity to ask questions [of the tutor] as well, like on a tutorial-based learning”.

c) The students using the computer were working as a true group, that is, they were interacting with each other. Andrew was using the computer because

“[cell division is] difficult to visualise as a continuous process ... hopefully [the program] makes a little bit more sense, you know, reinforces the picture that they've done, it helps their memories as well as giving them a different view of it. Of course it's, you know, it's a different activity as well, which helps.”

He wanted them to watch the animations of cell division

"and then to go through and read each section. Um, there were some questions on it which weren't working properly. We'd have needed more time for that. But ideally that's what I'd have liked them to [do] then have gone through it, self-testing as a group."

The following list shows the areas that Andrew concentrated on when talking about his classroom activities; the areas are shown in what appeared to the researcher to be the order of importance in Andrew's account:

1. looking at actual biological material
2. reinforcing the subject material to check understanding
3. reinforcing the subject material to check memory
4. adding some extra information
5. using different representations to check understanding
6. using changes of activity to maintain interest
7. working in groups to support understanding and aid memory.

Jim

Jim also had three activities set up during the second half of the class. He had just come to the end of several sessions on movement and the activities aimed to review and connect some of the main issues involved:

"I'm not asking them to produce any work this lesson, just to try and help them understand some ideas. So I thought it would be nice and loose."

The activities were as follows:

- a) One group was looking at models of various vertebrate skeletons:

"So I was really trying to get them ... to look at the different body structures that were present, and also, perhaps to look at the evolution ... of different animals, and pick out

particular bones. So we've got similar bones in a human, a rabbit, a frog and a bird and, like, er, try and see how it has become specialised for a different function."

b) Another group was looking at samples of arthropods alongside slides and a dissection book. Jim was hoping the students would examine the differences between internal and external skeletons:

"I was worried that they wouldn't have enough in that 15 minutes to fill - that they'd get bored. But they seemed to be quite interested in it, they were picking out things that they'd seen abstractly on slides last week and this week in books, or that we'd talked about."

c) The third group was using the computer program, and Jim was encouraging them to explore generally:

"Really I was just hoping that they'd look at the skeletal system, the muscle system, possibly the digestive system and perhaps the circulatory system, which has all been covered in the last month or so by myself and another teacher. And just to get them to see on screen some of the ideas which we've been talking about in class - like joints and that type of thing, or like how nerve impulses are conducted, or about how the blood pumps, perhaps linked to exercise. And also to get them, perhaps to think about using these CD-ROMs as a resource."

In summary, Jim appeared to be focusing on:

1. using different forms of representation to broaden understanding
2. keeping the students interested
3. getting students to intellectually engage with the material
4. looking at actual biological material
5. introducing students to a new resource

6. changing activities to maintain interest.

Pam

Pam had four activities set up for most of the two hour session.

a) The first activity involved one group working with her up at the board doing an introduction to muscles. She would normally have done this as a full 2 hour session with the whole group together but was altering it because:

"I wanted to talk to the less able students so they had some intro to your CD-ROM and the muscles, because I don't think it stands alone very well."

She stressed that she

"would actually take muscle up again next week ... Because there is no way I could let them go to the examination on the basis of that."

b) The second group was carrying out a brief experiment which appears on the A-level syllabus. For this they were using a microscope attached to a television monitor, which allowed several group members to see what was happening simultaneously:

"I always feel [it's] a bit of a waste of time as an experiment anyway. You know it's nice, it shows you, but it is over, isn't it, it's done. So I was quite happy to cut that down to 20 minutes."

c) The third group was finishing an exercise on the human skeleton from the previous week:

"I wanted them to actually interact with that skeleton, I want them to know all the bones, feel the bones, see the bones, know where the holes are ... it's got questions like, why are there holes in the cervical vertebrae, and again you've got to look at the holes and suss why they're there. So it's not a look at it and name it exercise, it's a think about

it exercise."

d) The fourth group was using the CD-ROM. Pam had asked them to look at worm movement, muscle contraction and anything else which interested them:

"I wanted them definitely to look at the worm burrowing and crawling, because that's actually quite difficult to show them in any other way... I don't have a bit of animation which has got that on, and when I saw it on your CD-ROM I thought, ah ha, that'll do it. And also the ability to go click, click, click on it so you can go into slow-motion, so if you take the time you can actually see what's happen, that's interesting."

In summary, Pam appeared to be focusing on:

1. covering the A-level syllabus
2. balancing time constraints against the "usefulness" of an activity
3. getting students to intellectually engage with tasks
4. getting students to interact with biological material
5. introducing theory required in other tasks
6. interesting the students
7. intellectually stimulating the students
8. using different forms of representation to reinforce understanding.

Summary

Although there were some interesting similarities and differences in the focuses of the three teachers' sessions, there are grounds for approaching these with caution. Firstly, the variation in the individual teacher's focus may have been affected by the subject matter or the curriculum stage, and may therefore have been very temporary. Secondly, the assumption is that the teachers' comments revealed the extent to which they valued different aspects of classroom activities. There are some difficulties here in

assuming that teachers readily articulate their priorities, particularly as the most fundamental of these priorities may well be operating on a largely unconscious level, and

"the things which are done automatically, even unconsciously, are the hardest to articulate and, in normal circumstances, teachers are rarely required to make them explicit." (Brown and McIntyre, 1993, p. 34).

Despite this, there were some tentative conclusions which could be drawn from a comparison of the three accounts. Firstly, there were the similarities. All three teachers stressed the importance of using actual biological material, using different forms of representation and maintaining interest. From this perspective it appeared to make sense that these teachers offered to try out software in the first place, and that they opted for software which they thought would maintain interest and provide a different representation of material already covered. It was also understandable that they felt such software needed to be supplemented with other activities, not only because of the constraints provided by having only one computer, but also because of the need for students to engage with actual biological material.

Secondly, there were several key differences which showed promise for assessing the teachers' different responses to the computer program, as follows:

a) Andrew and Pam appeared to have more of a focus on the subject matter itself than Jim. This may be because, as he said, Jim was aiming for a "loose" session, or it may have been because he was a less experienced teacher and measured success in his classroom more in terms of student enjoyment than in terms of his own independent sense of student learning. Pam also talked about student enjoyment, but this seemed to be more as a beneficial 'extra' than a way of evaluating the success of

her class.

b) Pam and Jim had more of a focus on the students themselves than Andrew. This was borne out in the general way in which they talked about their students; Andrew mentioned two of his by name when referring to modifications he had made in the class in response to their needs; Jim and Pam named, respectively, eight and 11 of theirs, talking more generally about their aspirations or characteristics, e.g.

"[This student] probably needs a job for a year, and then he'll be just fine. But he's come from a very tough school where I dare say they haven't had anyone who is as clever as him, or, um, they certainly haven't taught him the study skills he needs."

(Pam).

c) Pam had more focus on all-round intellectual gain in the shortest time than either Andrew or Jim. This could be because she was in the middle of teaching a topic, whereas they were both covering revision sessions. However, it was more likely to be the result of working to an outside syllabus and examination, whereas both Andrew and Jim were working to inside ones. Overall it meant that she was very critical about different activities and their value.

Pam had more of a focus on her role in the activities than either Andrew or Jim. Andrew's activities were fairly self-standing with him acting as support. Jim's were not so self-standing, but he did not isolate the fact that his presence was required to make a success and a focus of some of them. Pam, by contrast, was aware of both her personal ownership in setting up the tasks:

"so I was glad to get my skeleton up, and I know it works, and I know they learn well from it."

and in contributing to them:

"[they were] were highly animated and really interacting well, but then I was standing there with them - though they weren't doing it to please me, but you know I was able to hold them onto particular bits more."

d) Both Pam and Jim had more of a focus on the students' intellectual engagement than Andrew, which may have been impetus or a by-product of b) above. Whereas Andrew wanted the tasks to support their understanding of the topic, both Pam and Jim wanted the students to investigate and think deeply about the material. Consequently, they also evaluated parts of their class in terms of student gains, although, significantly, (and as in a) above) Jim aimed to ask the students directly:

"I'd be interested to know from them next week how they thought this lesson went, because it's completely new to get things out and look at them, and get a bit of time to do it. So I'd be interested to learn whether they think they got anything more out of it than they do normally."

whereas Pam was less reliant on what the students actually said, and more reliant on her own judgement and assessment:

"but he wasn't impressed by the CD-ROM, which is interesting, didn't find it useful. But then he hadn't interacted, had he?"

This analysis of the teachers' accounts revealed a large number of variables that may have influenced their perspectives on using software in the classroom. However, at this stage the variables appeared too numerous to allow for many generalised comparison to be made, and it seemed as though this problem would be compounded in the main study with the increased number of participants. Therefore the next section looks at how far the Brown and McIntyre (1993) framework was able to provide a meaningful and coherent framework within which further analysis could take place.

6.6.2 Findings examined within the Brown and McIntyre (1993)

framework

The Brown and McIntyre (1993) framework was described in Section 3.2.2. As a brief reminder, the framework suggests that:

- teachers organise their thoughts about their teaching around the setting up and maintenance of steady states of appropriate student activity (these are the Normal Desirable States of Pupil Activity, or NDSs)
- the NDSs underpin the flexibility and effectiveness of an experienced teacher
- many educational innovations rest on implicit ideas about how students should be working while using the innovation; that is, they are
"concerned with pupils' ways of working in classrooms, such as the nature of their talk, their practical activities, the sources of information they use, the ways they collaborate, the questions they seek to answer" (Brown and McIntyre, 1993, p. 116)
- these innovations therefore specify their own NDSs
- if these NDSs are at odds with the teacher's NDSs then the teacher may well find the innovation very difficult to incorporate into their classroom practice.

Although other concepts from the framework such as Progress, Teachers' Actions and Conditions (see Section 3.2.2) were used in the main study to describe Andrew, Jim and Pam's approaches to their teaching, the focus here was on the NDS to see how far a match or mis-match of NDSs could explain each teacher's experience of using the software in their classrooms.

There were some reservations about using Brown and McIntyre's framework for this analysis, primarily because it was developed with individuals who were, firstly, based in schools, secondly, experienced, and, thirdly, "good" teachers. With

respect to the second criterion, although both Andrew and Pam were experienced teachers, with eight and 16 years' teaching respectively, Jim had only 1 year's experience. With respect to the third criterion, satisfying this occupied a major portion of Brown and McIntyre's research; it was not possible to replicate this here.

A teacher's NDSs are best described by illustration, and this section illustrates those of Andrew, Jim and Pam in turn. There were some initial concerns about how the NDSs of the computer program could be gauged. Only one program came with the designer's suggestions about how it might be used in the classroom; this was *Mitosis and Meiosis*, used by Andrew, and his use was exactly in line with the designer's suggestions. Despite these initial concerns, the NDSs of the other two programs emerged quite strongly, both from the way in which the teachers used them, and from the way in which they talked about how they thought they were "meant" to be used; this was particularly obvious in Pam's deliberations on *How Animals Move*. Again, these NDSs are best described by illustration.

Andrew

Andrew's overall NDS for this session was that the students should work steadily in small groups or individually while looking at new representations of material which they had already covered; they should be particularly aware of looking at "real" biological material, rather than stylised representations. The students should be using the material and the other group members to "self-test" and take the opportunity to ask the tutor for clarification. The NDSs for each separate activity showed variations on these themes:

a) When using the microscopes students should be looking at relatively familiar

"real" material and identifying different stages of cell division using previous knowledge.

b) When using the bioviewers students should be looking through the pictures of relatively familiar "real" material, reading the associated text and asking questions of the teacher.

c) When using the computer students should be looking through the sequence of cell division, which should be relatively familiar, reading associated text and asking group members any questions about which they were unsure.

Mitosis and Meiosis is a short, structured tutorial, which shows the users animated sequences of cell division and allows them to look through the sequence screen by screen while reading the explanatory text. Its overall "feel" is very similar to that of the bioviewers, in that it has an obvious sequence, it covers the material to approximately the same depth, it provides visual images plus associated text and the information is presented in such a way that it would be best used by individuals or small groups who have already had an introduction to cell division. Therefore it seemed that Andrew's NDSs for this particular class fitted well with the NDS of the computer program, and this could explain why he felt happy about using the program again in a relatively unmodified form:

"I thought that it worked OK actually ... hopefully the overall process would have all slotted together to give a much broader and a much more realistic view of [cell division] as being continuous."

Jim

As mentioned before, Jim was a relatively inexperienced teacher and the classroom

set-up he was using during the observation was completely new to him:

"We're normally all doing one thing together. Um, not through any particular planning, it's just the way it's turned out ... so dividing them up into groups, I don't think has been done to them before."

So although Jim focused on a range of educational objectives when talking about the different activities he had organised (see Section 6.6.1), he did not talk in terms of how these activities and his actions might bring about a steady state of desirable student activity (NDS). This is best seen by comparing Jim and Pam's responses to a part in the observations where they each joined an independently working group:

So what are you [doing with this group] here?

"That was me looking at the top of the nose bone. Shortly after this Andy starts talking about evolution, and he's asking whether there are people that don't believe in evolution in academic circles. Um, and I didn't answer that, but the group had some views on it. "
(Jim)

You're up here [with the computer using group] now?

"Yes ... I've come back to give them a hand. Yes, because I saw them go to muscle ... So I wanted to be sure that they went right back to the beginning page ... and ... I didn't want them to get bored with it ... so move it on, move it on, and then as soon as they see the animation they then get the impetus to move back." (Pam).

The level of focus which was evident in Pam's account of her actions was not just attributable to the fact that she was aiming for a much more structured class than Jim. Although Jim was aiming for a very relaxed class it seemed to the researcher that he had set up the activities carefully, and that he was trying to keep them moving in order to interest and intellectually engage the students. However, the students' interest emerged in his account as serendipity rather than an objective, as follows:

"I thought the students wouldn't be particularly interested in the stuff at the back, and I thought they'd view the stuff at the front [the computer activity] as being a bit simplistic.

But I was pleasantly surprised - they seemed to be really interested."

Therefore it may be appropriate to say that Jim was not yet at a stage where he organised his thoughts about his teaching according to a clear NDS.

If the concept of mismatching NDSs can be used to describe the problems teachers have in incorporating innovations, it would seem to make sense that a teacher who does not yet have clear NDSs should find such incorporation less problematic (from the perspective of classroom dynamics) than a teacher who does. Jim's account may bear this out: he was happy to use the computer activity again in an unmodified form, even though it appeared to the researcher to be less structured and less likely to engender discussion and debate than his other activities. Because he did not have a clear NDS there was no clash occurring. This is seen most clearly by further comparison with Pam's account.

Pam

Pam's overall NDS in this session was that the students should be working in groups and all contributing individually to the group, that they should be working through pre-set activities in a specified time scale, and that these activities should result in the students being intellectually engaged, often physically active, and often "noisy" and involved. The NDSs for each separate activity showed variations on these themes:

- a) When working on the experiment, the students should be working as a group in which at least one student was competent at carrying out the practical but, ideally, all the students should be involved, following a schedule, observing and noting down the results.
- b) When working on the skeleton exercise, the students should be working as a

group, filling in the answers to the exercises in their individual worksheets, interacting intellectually with each other in order to answer the questions, and interacting physically with the skeleton.

c) When working with Pam up at the front the students should be following her account, assimilating new information, and interacting with her by answering and asking questions.

d) When working with the computer the students should be looking at the animations of muscle action and worm movement, checking what they were seeing against theory they had already covered, looking at the video of the fly walking, checking that against theory they had already covered and generally exploring the material in the CD-ROM.

The computer activity was the only one in which the students did not follow a clear sequence which involved thinking about specific questions, discussing the answers with colleagues and working at a definite pace. The NDS of the program seemed to be that the user should explore at their own pace, look at the variety of video clips and animations, and follow whichever of the numerous links appealed to them. Pam certainly picked this up and highlighted the problem that it caused her:

"So I wouldn't normally give them an activity to do which didn't have some sort of worksheet prepared, but I haven't put enough thought in here on what sort of a worksheet I could put on that. And I also thought I might lose the whole point of using the CD-ROM, which was to give them the opportunity to explore. But then I would want to eliminate three quarters of the information, you know what I mean, so they don't go wandering off."

In saying this, Pam appeared to be identifying directly the mismatch between her own NDSs and the NDS of the program.

Pam's conclusion was that she would need to modify the computer activity quite considerably to be able to use it effectively. The quote below gives a fuller sense of the difficulties she experienced in deciding how to use the program, and highlights possible modifications following her experiences of using the program the following day with another group:

"[The students in the other group] were highly animated and really interacting well, but then I was standing there with them - though they weren't doing it to please me, but you know I was able to hold them onto particular bits more, you know, to prompt, is, I suppose, the word I'm looking for, they plainly got a lot out of it, they enjoyed it and they wanted to see more of it, they said - could they get it, they felt there was something in it, which the other group didn't ... I don't know, maybe (pause) there would need to be questions on it to make them interact, *and that is actually against the whole spirit of the CD-ROM*, isn't it?" (my emphasis).

6.7 Observation conclusions.

The pilots study findings were based on three single observations, therefore the conclusions were tentative. However, several aspects emerged from the observations, as follows.

The teachers organised their classes in strikingly similar ways, possibly in order to cope with the restrictions imposed by having access to just one computer. However, it emerged that both Andrew and Pam used these types of small group activity with their students on a regular basis, even when not using the computer.

Overall the teachers indicated that they felt the sessions were fairly successful; all three said they would use the computer program again. This was particularly clear with Andrew and Jim, who suggested they would use it again in a similar format. By

contrast, Pam felt that the program had potential, but its use in her classroom would have to be more tightly structured.

The teachers talked about their observed sessions in a very rich way, revealing a wide variety of focuses. These were to do with affective issues (such as students' enjoyment), pedagogical issues (such as students' intellectual engagement), the subject matter itself (such as the importance of interacting with biological material) and practical issues (such as covering the syllabus).

Within this richness, Brown and McIntyre's (1993) NDS concept seemed to provide a way of describing some significant aspects of teachers' interactions with software. However, two points need to be made. The first is that the framework was developed with experienced teachers, and the findings from Jim's observation indicated that it might not be applicable for inexperienced teachers. The second is that the NDS concept did not encompass the full richness which emerged from the 'general' analyses of the teachers' accounts (see Section 6.6.1). For example, key areas which were not addressed by the NDS but which emerged as important included the students' characteristics and the learning aims and objectives. Therefore there seemed to be a need to consider other concepts from the Brown and McIntyre (1993) framework, such as Progress, Teachers' Actions and Conditions (Section 3.2.2) in order for this richness not to be lost.

6.8 Overall conclusions and their implications for the main study

In this section the conclusions from the interviews and observations are summarised and their implications for the structure of the main study are discussed. Following the survey the five main factors under investigation were identified (Section 5.1) as:

1. resourcing
2. the influence of colleagues
3. perceived usefulness of CAL
4. educational philosophy
5. classroom dynamics.

The pilot study was designed to explore these five factors and determine how far the research plan outlined in Chapter Five needed to be modified for their further exploration in the main study. The conclusions were as follows.

1. **Resourcing.** The interviewees concentrated on hardware when answering questions about resourcing; information about software resourcing derived primarily from the interviewees' discussions about their ideal software. In five of the six cases the interviewees stressed that funding was directed towards centralised computer suites, leaving classrooms and/or laboratories very under-resourced. It emerged that the teacher's view of what constituted adequate resourcing, both in terms of hardware and software, depended to a large extent on their classroom dynamics.

Overall it was felt that the resourcing questions yielded rich information about the interviewees' resourcing concerns and did not need to be modified for the main study. However, the pilot study group numbers were too small to allow comparisons of the effects of resourcing on the interviewees' CAL use, and so this was seen as an important area for investigation in the main study.

2. **Influence of colleagues.** The importance of being exposed to, or having been exposed to, the computer use of other teachers emerged from both the literature review and the survey. None of the pilot study group members could identify colleagues whom they felt were using computers well. Those who were using CAL therefore

seemed to be operating very much in isolation. Although this was interesting in itself, it was clear that a larger number, and therefore a broader mix, of teachers in the main study should allow some useful comparisons to be made between those who had, and those who did not have, computer-using colleagues.

3. Perceived usefulness of CAL. According to their survey responses the interviewees were all enthusiastic about CAL use. The interviews explored this enthusiasm on two levels, on a fairly abstract level during the First Interviews and on a more concrete level during the Second Interviews.

During the First Interviews the interviewees were asked about their ideal CAL. Three of them had not really considered this before. The other three had clear ideas, which suggested they had been active in their search for specific CAL applications. One of these three was a computer enthusiast and the other two were teachers with *managerial roles*; it was suggested that the two with *managerial roles might have been* active in their search for suitable CAL because they felt the need to incorporate the use of such CAL into their areas of responsibility. One of the managers was particularly detailed in describing her ideal software, and talked about programs which could overcome specific pedagogical problems; Draper (1998) describes such programs as those likely to show “niche-based success”.

The Second Interview gave more concrete information about the interviewee’s perceptions of the usefulness of CAL. The interviewees were generally enthusiastic about the software they reviewed, and this was in line with their survey responses. Where they said they would not use a program in the classroom but would use it outside, their reasons were primarily that the program would be too time-consuming and inflexible for classroom use. These reasons generally accorded with those

emerging from the survey (see Section 4.3.6). The strongest opinions came from those with managerial roles, both of whom reviewed programs they would not use at all. Their objections to the software were in line with, in one case, their specific requirements for software, and, in the other case, their conceptions of teaching and learning. These requirements and conceptions both emerged from the First Interviews.

In general it was not felt that the structure of the questions on the perceived usefulness of CAL needed to be modified for the main study, but it was felt that the main study analysis needed to include considerations of how previous exposure to the use of computers in HE impacted on the interviewees' views of software. It was also felt that the main study analysis should include an exploration of the ways in which the teachers said they would use the software in their classrooms.

4. Educational philosophies. The Prosser, Trigwell and Taylor (1994) framework was used to gauge the interviewees' conceptions of teaching and learning. This was fairly straightforward to apply and there was only one case in which the classification did not "ring true".

No direct link was evident between the interviewees' conceptions of teaching and learning and their frequency of CAL use. However, as mentioned under 3., above, in one case there was a relationship between the interviewee's conceptions and his attitude towards specific pieces of software. This was with Bruce, who held the most student-centred conceptions possible.

Bruce was the only interviewee who was classified as strongly student-centred according to the Prosser et al (1994) scheme. Because his student-centredness appeared to link with his perceptions of the usefulness of the software he reviewed, it was thought that it would be useful to ensure that the main study included some more

strongly student-centred teachers. Therefore, two FE biology teachers who were known to the researcher as student-centred, but who had not completed the survey, were asked if they would be involved in the main study.

5. Classroom dynamics. The observations aimed to get a clearer sense of the nature of the classroom dynamics factor. Analysis of the teachers' comments on their observed classes indicated that the integration of software was problematic when there was a mismatch between the teacher's and the program's NDSs. However, the findings from the three observations were tentative and it was acknowledged that the main study would benefit from second observations with the same three teachers while they were teaching different syllabus areas. It was also hoped that an additional observation with Jim, after another year's experience, might show whether he had begun to develop NDSs; in the event it was not possible to observe Jim a second time. It was also felt that the main study would benefit from increasing the range of teachers involved, and to this end additional single observations were planned with another three teachers.

There were four concerns about the structure and interpretation of the observations. The first was that there was a great deal of rich information arising from the observations which the NDS did not encompass. Therefore it was decided that the main study observation analysis should also include the other concepts which made up the Brown and McIntyre (1993) framework, especially Conditions and Progress.

The second concern was that during the pilot study observations both the software and (for the most part) the hardware was provided by the researcher. This would have altered the teacher's normal organisational constraints, possibly resulting in reduced information about how hardware resourcing, software resourcing and the resolution of technical difficulties impacted on their classroom dynamics. To overcome this it

was decided that some of the future observations should focus on teachers using their own resources.

The third concern was that the pilot study observations had all been carried out on individuals using particular programs for the first time. It was thought that it would be useful for the main study to involve some observations with teachers using software with which they were familiar, and that this would be a natural outcome of observing teachers using their own resources.

The fourth concern was that the pilot study contained no investigations of emancipatory software (see Section 6.1.2) such as experimental interfacing, data analysis or the Internet. It was decided that it would be valuable to include observations of teachers using this kind of software in the main study.

Finally, the pilot study revealed some of the connections between different factors on the obstacle course. This was shown in Figure 6.1, which is reproduced below.

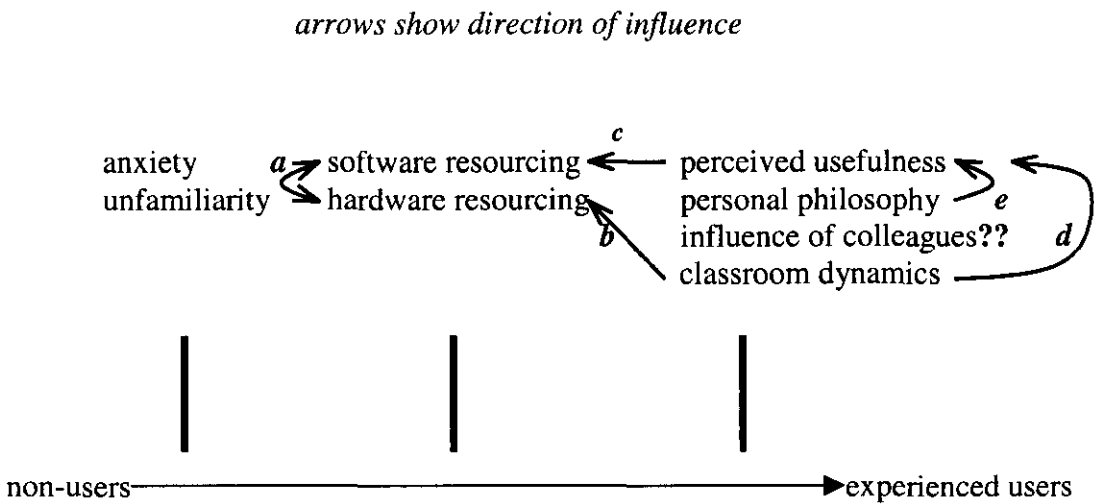


Figure 6.1 The modified obstacle course

However, the findings were not able to reveal much about how the teachers might navigate the obstacle course to become extensive/expert users of classroom technology. This was primarily because the numbers in the pilot study group were too small to allow cross-case comparisons on how the interviewees' different experiences (with respect to the factors on the obstacle course) impacted on their CAL use. Such comparison was seen as a primary aim of the main study.

Chapter Seven: Main Study First Interviews

Following the pilot study the First and Second Interviews were carried out with another 14 individuals. The responses of all 20 interviewees (i.e. the pilot study group and the main study group) were analysed together. This chapter describes the First Interviews under the following headings:

7.1 Some practical aspects. This section briefly describes some of the practical aspects of conducting the First Interviews, and outlines the broad approach used in the analysis.

7.2 The interviewee group. The general features of the interviewee group are outlined in this section and compared with the survey group as a whole.

7.3 Resourcing constraints. The interviewees' resourcing levels are described in this section and the relationship between resourcing level and CAL use is explored.

7.4 Influence of colleagues. This section outlines the interviewees' perceptions of their colleagues' computer use, and investigates the relationship between this and the interviewees' own CAL use.

7.5 Attitude towards biological CAL. This section describes the interviewees' opinions about currently available biological CAL packages, and what they would like to see in their ideal CAL packages.

7.6 Conceptions of teaching and learning. The interviewees' educational philosophies are outlined here, and the relationship between educational philosophy and CAL use is explored.

7.7 Follow-up questionnaire. This section summarises how the interviewees'

computer-using circumstances had changed a year after the interviews.

7.8 Conclusions. Here the findings from the First Interviews are summarised and related to the obstacle course.

7.1 Some practical aspects.

The format of the First Interviews was described in Section 5.5.1, practical considerations in Section 5.6.1, and the broad analytical approach in Section 5.7. This section describes some additional aspects to setting up, carrying out and analysing the First Interviews.

The survey respondents who had indicated a willingness to be involved in further interviews and observations were contacted by telephone from October 1996 onwards to arrange interview dates. At this stage the interview process was described in more detail and the potential interviewees were encouraged to ask any questions or say whether they wished to withdraw from the procedure.

Of the final 20 who were interviewed, 17 came from the survey respondent group. A further three came from outside this group. One of these three (Stephen) had volunteered himself for the process after a colleague was interviewed. The other two (Judy and Graham) were known to the researcher and were included because they were articulate and student-centred (see Section 5.4.2 and Section 6.8). These three had not answered the survey questions, and were therefore contacted by telephone again before the main interviews to build up a profile of their current and historical computer usage.

The interviews lasted between 45 and 75 minutes each. They were recorded and transcribed. The first 10 interviews were fully transcribed, and, after the initial analysis for the pilot study, the remainder were partially transcribed. Initial notes were made

immediately following each interview and the scripts were analysed following the broad approach outlined in Section 5.7. Extensive use was made of coding and matrices, with the researcher moving backwards and forwards between extracted data and original transcripts in order to retain the integrity of the original text. During the analysis of the teachers' educational philosophies, the researcher's categorisation was checked by another researcher (see Section 7.6). Additional methodological details are given throughout this chapter where it is thought that these will be useful to the reader.

7.2 The interviewee group

One of the aims of the sampling was that the interviewees should be broadly representative of the survey group in terms of their computer literacy, their precise subject teaching area and their current CAL use (see Section 5.4.2). This section compares the interviewee group with the survey group as a whole in order to examine how far the sampling had achieved this aim. Table 7.1 shows the profile of the interviewee group as drawn from their survey responses, or, in the case of the three who came from outside the survey group, from subsequent telephone conversations (see Section 7.1).

The interviewee group compared with the survey respondent group as follows:

- a) The survey group was 53% female and 44% male. The interviewee group was 45% female and 55% male. Therefore, as with the pilot study group, males were represented more in the interviewee group than the survey group.
- b) Roughly half (53%) of the survey group had been in teaching for more than 15 years. Only seven (35%) of the interviewees had been in teaching for more than 15 years.
- c) Less than half (41%) of the survey group had used computers in HE. This contrasted

quite strongly with the interviewee group, where 13 (65%) had used computers in HE.

Table 7.1 Overall profile of the interviewee group

Name of teacher	Location of college	Years in teaching	Did they use computers in HE?	Access to computers at home (no. of applications used)	Access to computers at work (no. of applications used)	Current level of CAL use	Levels taught at (in NVQ terms)
Andrew	London	8	✓	✓ (1)	✓ (1)	monthly	2 3
James	Hants.	12	✓	✓ (9)	✓ (1)	monthly	3
Bruce	Beds.	18	×	✓ (4)	✓ (3)	none	3
Liz	Surrey	15	×	×	✓ (0)	none	1 2 3
Beth	Kent	5	✓	✓ (4)	✓ (1)	monthly	2 3
Maria	Oxon.	17	×	✓ (3)	✓ (2)	monthly	3
Jim	Essex	1	✓	✓ (2)	✓ (5)	none	2 3 4
Peter	Sussex	10	✓	✓ (1)	✓ (5)	weekly	2 3
Mark	London	15	×	✓ (5)	✓ (3)	none*	3
Phil	Herts.	8	✓	✓ (5)	✓ (5)	occasional	2 3
Linda	Norfolk	7	✓	✓ (3)	✓ (5)	occasional	2 3
Simeon	Cheshire	2	✓	×	✓ (4)	none	2 3 4
Pam	London	16	×	✓ (6)	×	n/a	3
Bill	Suffolk	22	×	✓ (2)	✓ (3)	none*	2 3
Angela	London	7	×	✓ (7)	✓ (1)	occasional	1 2 3
Stephen	Surrey	2	✓	✓ (7)	✓ (5)	occasional	4
Gary	Surrey	8	✓	✓ (4)	✓ (5)	rare	3 4
Jean	Hants.	10	✓	✓ (4)	✓ (3)	rare	1 2 3
Judy	London	16	✓	✓ (4)	✓ (6)	rare	2 3
Graham	London	10	✓	✓ (7)	✓ (3)	monthly	1 2 3

✓ = yes

×

* = anomalies which are discussed in the remainder of this section.

d) Most of the survey respondents and interviewees had access to computers both at

home and at work. One interviewee, Pam (*see Table 7.1), did not have access to a computer at work at the time of the survey, but managed to acquire one shortly before the interview.

e) The survey respondents used, on average, approximately three computer applications at home and at work. The interviewees also used approximately three applications at work, but used four at home. Therefore they appeared to be slightly more enthusiastic home-computer users than the general survey group. The number of applications used per person ranged from zero to nine, therefore computer use amongst the interviewee groups covered a broad range.

f) Both the survey group and the interviewee group were generally enthusiastic and/or optimistic about the use of computers in education. The overall breakdown of levels of enthusiasm for both groups is shown below.

Category	Numbers in survey group (out of 68)	Numbers in interviewee group (out of 20)
very positive	14	2
positive	43	18
negative	7	0
very negative	2	0
unclear	2	0

g) Almost half of the survey group made no use of CAL; the approximate usage is shown overleaf. By comparison, the interviewees' use of CAL was spread more evenly between the three main categories. This is likely to be because the interviewees had had

more exposure to use of computers in HE (see Section 4.3.4).

CAL use	Numbers in survey group (out of 68)	Numbers in interviewee group (out of 20)
no use	30	6
rare or occasional use	18	7
monthly or more frequent use	15	6
unclear or not applicable	5	1

There were some concerns following the survey that the findings for frequency of CAL use might have been affected by the respondents’ different understandings of exactly what constituted “CAL” (see Section 4.3.4). Because of this the interviewee group was asked what they had meant by CAL. Responses indicated that most of them had been using a very broad definition, for example:

“[CAL refers to] any application which you can use to, er, broaden learning experience.” (Andrew)

This view typically included using simulations, information sources, spreadsheets and experimental interfacing. More rarely it also included using programming, word processing and constructing web-sites.

Anomalies only arose in two cases. These were with Mark and Bill (*see Table 7.1) who both described themselves as making no use of CAL, but emerged during the interview as making rare use of experimental interfacing and CD-ROMs, respectively. In Mark’s case this was because he did not include experimental interfacing in his definition of CAL. It was not clear why this discrepancy arose in Bill’s case since he included the use of CD-ROMs under his definition. In the remainder of this account both Mark and Bill are recorded as having “rare” CAL use as opposed to “none”.

h) The survey group mostly taught at NVQ 3 (A-level equivalent), with the second most common level for teaching being NVQ 2 (GCSE equivalent). Twenty percent also taught at NVQ 4 (degree level) and a different twenty percent also taught at NVQ 1 (entry level). This was exactly matched in the interview group, where most taught NVQ 3, fewer taught NVQ 2, four taught NVQ 1 (Graham, Angela, Liz and Jean) and a different four taught NVQ 4 (Simeon, Jim, Stephen and Gary). Most of the interviewees' primary teaching area was biology or human biology. However two of the interviewees had rather more specialised teaching areas; these were Gary, who taught pharmacology, and Jean, who taught fish science.

In summary, the interviewee group was broadly representative of the survey group in terms of computer literacy, subject teaching area and current CAL use. The main areas of difference were that:

- there were proportionally more males in the interviewee group
- the interviewee group had fewer years in teaching
- the interviewee group had more experience of computers in HE
- the interviewee group had slightly more use of CAL.

7.3 Resourcing levels

The interviewees were asked about their general resourcing levels, who controlled what hardware and software was bought, and what they would have to do if they wanted to use computers in their classrooms. As in the pilot study, their answers focused mainly on issues to do with hardware resourcing. The pilot study findings indicated that most of the hardware resourcing went towards centralised computer suites, and that teaching

area computing was poorly resourced (see Section 6.3.1). The main study findings showed a similar disparity, and the following two sections deal with centralised and teaching area resourcing in turn.

7.3.1 Centralised computer facilities

A great deal of information came up about centralised computer facilities (referred to variously as computer suites, resources centres and learning centres). This was unsolicited and therefore seemed to indicate that such suites were seen as the major computer resource by most of the interviewees; this made sense in terms of the disparity between computer suite resourcing and classroom resourcing.

Only one of the interviewees complained that the hardware provided in the suites was inappropriate for the students. For the most part the suites were seen as being well resourced, but difficult to get access to, e.g.

“We book the room probably at least 3 to 6 months before we need it, because the pressure is so much on that room that they have to timetable so far in advance. And there's always difficulty with it, even when you make that preliminary booking they always come back to you and offer you different times to try to get you slotted in.”
(Stephen)

“We can't book them into the IT centre, it's a first-come-first-serve thing. So that means if you're taking a group of students up you take a bit of a chance on whether they can get onto the internet or not.” (Maria).

Six of the interviewees mentioned the additional problem of trying to teach, or learn, in the suites, e.g.

“We had a large computer suite - we've got about, oh, 50, 100 over there, but that's not useful for a biology class, because I feel you need to be in the classroom to teach with it.” (Pam)

“We don't have a lot of computers in the classroom anyway, so we're restricted to

what's called the learning centre. And whether it fulfils its title and people learn there is another matter.” (Simeon).

Some were particularly vociferous about the politics and pedagogy of having centralised computing suites, e.g.

“[Management] want to put [computers] in separately, they think this is somehow more efficient. Of course it isn't because students absolutely hate going up there, they just don't like trekking away from their curriculum base. They're just a good tool, they need to be under your fingers, like anything else.” (Angela)

“If you're in administration you've got absolutely no problem getting another computer, you walk into the offices and there's computers on every desk, but for the teacher - different world completely.” (Mark)

“[The principal] is building an area for open access, because this is the way he feels Further Education is going, where a tutor will take students to a bunch of computers, and students will interact with the screen, and the tutor will sort-of swan around ... I was so distressed by this I took some of them to [a local university] to have a look at the open access area there, which, even with fairly mature students, it's difficult to occupy. So with our students ... it's going to be virtually impossible. This he won't accept.” (Pam)

Only one interviewee put the opposing view, which is that she would prefer to see teachers and students move out of classrooms into resource centres, rather than computers being moved out of resource centres into classrooms: interestingly this was the only interviewee who was a senior management member. Also interesting was that none of the teachers appeared to be formally timetabled in the resource/learning/computer centres, despite Gray and Warrender's observation that

“teachers [are] increasingly expected to ... spend time within [learning] centres supervising and supporting student learning.” (Gray and Warrender, 1995, p. 1).

Instead the interviewees' focus was primarily on how difficult it was for them to gain access to these centres with their students.

7.3.2 Teaching area computing

There was a marked contrast between central computer suite resourcing and the teachers' normal teaching area resourcing. Table 7.2 gives a rough indication of the resourcing levels found in the teaching area. In this the interviewees are placed into four groups. These groupings aim to represent *actual* resourcing, rather than the teachers' perspective of their resourcing, but invariably there are anomalies which arise because of the open-ended and interviewee-led nature of the interviews. For example, Gary and Stephen were both in the same department, but Gary described his resourcing as follows:

“I think there are one or two lap tops around ... but I find they tend to be too much of a fiddle to get those set up.” (Gary)

Gary was therefore categorised in the *Lowest Resources Group*. By contrast Stephen talked about the available systems as being accessible and useful, and he was therefore categorised in the next group up.

The broad outline of the three groups is as follows.

1. The first group (*Lowest Resources*) includes those who only had access to BBC computers or who described themselves as having effectively no computing power in their normal teaching area. Nearly all the interviewees had some access to BBCs, and therefore the resourcing described in the next three groups is in addition to at least one BBC.
2. The second group (*Low/Mid Resources*) includes those who had access to one 286, or one or two laptops which could be booked and brought into their teaching area.
3. The third group (*Mid Resources*) is more mixed than groups 1 and 2, and includes those who had either one fixed faster machine (e.g. a Pentium) or two to four slower

machines within relatively easy access (e.g. a small room between the labs with four 286s).

4. The fourth group (*Highest Resources*) is also fairly mixed, and includes those who had relatively easy access to three or more faster machines.

The third column of Table 7.2 aims to show the *attitude* of the lecturers to their level of resourcing. The interviewees were not questioned directly about their attitudes, and therefore many of the accounts about resourcing were fairly neutral.

Table 7.2 Resourcing in the teaching area

Group	Interviewee	Computers in teaching area	Interviewee's opinion of this resourcing
<i>Lowest Resources</i>	Andrew	1 BBC on trolley	no comment
	Liz	1 BBC on trolley	no comment
	Beth	1 BBC on trolley	no comment
	Angela	up to 3 BBCs on trolleys	no comment
	Simeon	effectively none	no comment
	Gary	effectively none	no comment
	Pam*	effectively none	deeply frustrating
<i>Low/Mid Resources</i>	Bruce	1 286 in science corridor	problematic
	Mark	1 286 in lab	deeply frustrating
	Judy	1 286 in lab	deeply frustrating
	James	1 staffroom 286 on trolley	problematic
	Stephen	1 or 2 laptops with projector	problematic
	Jean	1 laptop	no comment
<i>Mid Resources</i>	Maria	1 286 and 1 staffroom 486 on trolley	no comment
	Jim	4 286s in a room between the labs	no comment
	Pam*	1 Pentium on a trolley	no comment
	Phil	486 in lab plus some 286s on trolleys	no comment
<i>Highest Resources</i>	Linda	6 486s in a room near the labs	very positive
	Peter	3 roving multimedia machines	very positive
	Bill	1 fixed 486 plus 3 others on trolleys	generally positive
	Graham	5 fixed high level Macs	generally positive

*Pam is shown twice because she taught on two sites.

Two aspects appear striking here; the first is the low level of resourcing, with over half the interviewees having access to only one BBC or 286 or similar (this would be with, typically, about 20 students). This level of resourcing is far below the 486 (or equivalent) standard which was cited, following the 1996-97 FEFC national survey, as the minimum standard felt to be acceptable by most colleges (FEFC, 1998). The second striking aspect is the teachers' variable opinions of their resourcing levels.

The *Lowest Resources Group* teachers rarely complained about their poor resourcing levels. The notable exception was Pam, who complained about the resourcing at one site, but made no comment about the resourcing at the other site. Several of the others in the *Lowest Resources Group* appeared not to be vociferous about their lack of resourcing because they had a different focus. For example, Beth and Simeon stressed that their classroom resourcing was going to be increased greatly in the near future, and Angela was not too concerned about the lack of hardware in her classrooms because she was unable to find suitable software to use on it anyway.

The *Mid Resources Group* teachers, similarly, had few comments to make about their resourcing levels, although Pam stressed the difficulty involved in trying to persuade managers to fund classroom computing.

The *Low/Mid Resources Group* stood out, however, with comments such as:

"We have thousands of pounds of interfacing equipment - we've got one 286 to run it on ... I sent a message over to IT saying, the GNVQ all need to use the heart monitor, is there any possibility of having another computer for a couple of weeks, ha! was the reply." (Mark)

"[We] always run across the problem of one computer or maybe two, it just kills it." (Judy).

The *Highest Resources Group* also stood out, with all four teachers in this group being positive about their levels of resourcing. However, there was a clear division in this group, with two of the members experiencing some frustration with their hardware:

“[The computers] should be fully connected up and working, but they’re not because [the technicians] haven’t put the socket in despite being asked to a year and a half ago” (Graham)

“I’ve been trying for five years to get a scanner, without success.” (Bill)

and the other two being far less equivocal:

“We have other facilities within the staffroom area for project work - scanners and things like that.” *It’s fairly well equipped then?* “It wasn’t, but it is now.” (Peter)

“So far we’ve managed to get most of what we’ve wanted.” (Linda).

Two aspects seem worth stressing here; the first is the contrasting comments made by the *Lowest Resources* and *Low/Mid Resources Groups*. The teachers in the *Lowest Resources Group* made, for the most part, very enthusiastic statements about the BBC programs they used in their teaching. It may be that some of their lack of complaint about their resourcing was because they had worthwhile programs which could run on the available hardware. In contrast, the *Low/Mid Resources Group* had moved away from BBCs and had fairly basic PCs. It may be that these teachers were now beginning to use a different set of software, much of which would be continually updated and designed for better resourced teaching areas, hence their frustration.

The second aspect worth stressing is that Linda and Peter were the only two teachers who felt that they had a clear say in the purchase of hardware. More common were the 14 interviewees who:

“sort of get what we’re given” (Maria),

or who had some limited say, gained only after:

“considerable hard work and persuasion” (Pam)

and having to:

“argue like mad” (Graham).

It was obvious that both Linda and Peter's influence resulted from the action of one specific person with computing knowledge and departmental influence. In Peter's case he was the one who knew about computers and understood how to use the FE system in order to get resourcing. In Linda's case it was the Head of Department who had spearheaded the development of the science computing resources. It was also obvious in a number of other cases (e.g. Pam, Graham, James, Bill) that the interviewees had taken on a personal responsibility for trying to increase resourcing levels in their teaching areas.

Resourcing emerged from the literature review (see Chapters Two and Three) as having a profound effect on teachers' CAL use; low resourcing was found to inhibit use (e.g. Downes, 1993) and high resourcing was found to be linked with increased/improved use (e.g. Becker, 1994). The pattern evident amongst the interviewee group was not so clear cut, and is shown in Table 7.3, overleaf.

Table 7.3 The interviewees' resource level and CAL use

Resourcing level	Interviewee	Opinion of this resourcing	CAL Use
<i>Lowest Resources</i>	Andrew	no comment	monthly
	Liz	no comment	none
	Beth	no comment	monthly
	Angela	no comment	rare
	Simeon	no comment	none
	Gary	no comment	rare
<i>Low/Mid Resources</i>	Bruce	problematic	none
	Mark	deeply frustrating	rare
	Judy	deeply frustrating	rare
	James	problematic	monthly
	Stephen	problematic	occasional
	Jean	no comment	rare
<i>Mid Resources</i>	Maria	no comment	monthly
	Jim	no comment	none
	Phil	no comment	occasional
<i>Highest Resources</i>	Linda	very positive	occasional
	Peter	very positive	weekly
	Bill	generally positive	rare
	Graham	generally positive	monthly

*Pam has been excluded from this table because of the change in her computing circumstances between the survey and the interview.

As can be seen, the pattern is very mixed, with the most frequent use (monthly) being spread throughout all four resourcing groups, and the least frequent use (none) being spread throughout the first three resourcing groups. It may be significant that the members of the *Highest Resources* group all made *some* use of CAL.

It might be expected that there would be a closer relationship between the interviewees' opinions of the adequacy of their resourcing (shown in the third column) and their CAL use. Again, there is no straightforward pattern evident here, although it is possible that a pattern might have emerged from *direct* questioning. The findings instead suggest that above a certain level of resourcing (in this case, one basic computer per laboratory) other factors come into play which may obscure the direct effect of resourcing on the teachers' level of CAL use; this point is returned to in Section 7.7.

In summary

- There was considerable disparity between centralised computing resourcing and teaching area resourcing.
- Many of the interviewees were unhappy with the focus on centralised resourcing, both in terms of accessing the resources and managing their own teaching, and in terms of student learning in these areas.
- Improvements in teaching area resourcing appeared to be due to the efforts of one individual in the department.
- Those with the highest level of resourcing all made *some* use of CAL
- There was evidence that the teachers' perceptions of the adequacy of their hardware resourcing depended to an extent on how well it was able to run software which they valued, rather than on some theoretical benchmark.
- Overall it seemed as though the relationship between resourcing and CAL use was not as clear as might be supposed from the literature review, or the survey findings (however, see, also Section 7.7).

7.4 Influence of Colleagues

None of the pilot study group had colleagues who they felt were using computers effectively as part of their teaching (see Section 6.3.2). One of the conclusions of the pilot study was that the individuals involved were working in isolation with respect to their computer use, and that although this was interesting in itself, it would be valuable to compare them with individuals who were working in more of a computer-use environment.

As before, the interviewees were asked if their colleagues were using computers effectively as part of their teaching. This question aimed to be fairly open-ended so that concerns or attitudes could emerge in a fairly unconstrained fashion, therefore, no definition was given about what might constitute effective use. As a result some of the interviewees addressed "effective use" as being specific to biology packages, e.g.

“If you're meaning using specialised packages for biology, or for whatever science they might be teaching, no, I think the short answer is, there is no-one being very sophisticated in that sort of sense, or using very interesting software.” (James)

whereas others approached "effective use" in a more general fashion:

“There's some very good stuff going on with basic IT skills”. (Angela)

The overall answers to the question were as follows.

Are your colleagues using computers effectively as part of their teaching?

Yes	6
No	8
Don't know	3
Unclear answer	3
Total	20

Three individuals were recorded as giving unclear answers, but actually, over half

the answers lacked clarity, even though the majority eventually emerged with a "yes" or "no". This lack of clarity was not noticeable in any of the answers to the other questions. The fact that it occurred here may be because:

- a) the question was relatively ill-defined, or,
- b) the interviewees were reluctant to criticise their colleagues.

However, with respect to a), where other questions were ill-defined the interviewees seemed happy to ask for clarification. With respect to b), the focus of the interview was on the problem areas which emerged with respect to teacher's use of computers, and it was very clearly directed away from any blame issues, so it seems unlikely that criticism of colleagues was a major factor in causing confusion over this question. Additionally, as can be seen from the quotes below, for the most part the individuals included themselves, rather than just talking about their colleagues, when stressing that there was no effective use.

The lack of clarity may instead have resulted from the essentially closed nature of most classrooms (e.g. Cuban, 1993; Doyle and Ponder, 1977) where individual teachers are not really sure what other teachers are doing. A couple of the interviewees addressed this directly when responding to the question:

"Ah? Have I seen somebody? ... It's a bit difficult, not immediate, you know. The people I see mostly are these people here (indicating her small staffroom, which has 2 other occupants) where I actually can see their teaching." (Maria)

"I'm not aware of how much use it gets." (Andrew).

Of the eight interviewees who said there was no effective use, three blamed this on poor software, e.g.

"[It's] not because of lack of knowledge, but because it's difficult to get software which

we like.” (Bruce)

“I don't think we are [using computers effectively], but I don't think that's because staff are not willing to or they don't want to. It's just a) the stuff's not there and b) we haven't got time to develop it.” (Simeon).

The importance of time was also emphasised by another two interviewees, e.g.

“We tend to use traditional means because of the resourcing - it's availability, it's time to develop things, to look at packages and see how good they are, and whether they're appropriate for our students.” (Gary)

Of the six who said that there was effective use, two were in the *Lowest Resourcing Group* and gave slightly ambiguous answers about whether their colleagues were using computers well, e.g.

“Um, no nobody's using them at all. I'm it really. Graham, who you know, he's very keen ... So, yes, he's very keen and he would use it.” (Beth)

“Well because of the restriction of the fact that they're not actually in the classroom, that limits what people do with them really. I mean there's some very good stuff going on with basic IT skills [word processing, Internet access etcetera]. Various people use data-logging with the BBC, which seems a bit primitive, but the BBC's pretty good for data-logging.” (Angela)

It was striking that the other four who said there was effective use were far less equivocal. These four clearly stressed the collaborative nature of the development of CAL use in their departments. They also had a clear awareness of what their colleagues were actually doing with computers in their teaching. This awareness, coupled with the emphasis on collaboration, distinguished these four from the rest of the interviewee group. Additionally, three of the four had the better resourcing levels in their teaching areas, and, as with the effective resourcing, use was motivated by clearly identified individuals from within their departments, e.g.

“Head of department, he's very enthusiastic, which is why we've got the science

resource room, and he's good with the students in the classroom and he makes maximum use of it. That's why there's always been a good push towards using the software.” (Linda, *Highest Resourcing Group*)

“Being scientists we've got data loggers ... and we nearly all teach GNVQ students and they have a very high input of IT ... So you're almost kind of pulled into it even if you didn't take to it naturally ... I was interested in computers from quite a few years back, and one of the chemists was as well, and we had a physicist for a short time who was also very interested. And I think between the three of us we sort of brought it in.” (Phil, *Mid/High Resourcing Group*)

“I probably use them more than anybody else, and that's because, well, at the end computers come down to me in the department, I mean it's me who looks after them ... There's a lot of exchange - we're all on a learning curve and we all just accept that - we haven't got anyone who keeps information back - we all find out things for each other.” (Graham, *Highest Resourcing Group*)

It seemed as though, if the answer was *yes*, *there is effective use*, then these interviewees were very clear not only about the extent and type of usage in the department, but also about the influence it was having on them. By contrast, when the answer was *no*, the interviewees generally worked this out while they were talking, because it was not immediately apparent. The above comments also suggest that the openness and collaboration within the department was a stimulus for use of CAL by all departmental members. Table 7.4, overleaf, explores this further by examining the link between the individual's level of CAL use and whether they thought their colleagues were using computers effectively; as before Pam has been excluded because of the change in her circumstances.

Table 7.4 Interviewees' CAL use and their colleagues' influence

Are colleagues using computers well?	Interviewees' own use of CAL			
	None	Rare	Occasional	Monthly or more
Yes		Angela	Phil Stephen Linda	Beth Graham
No	Bruce Liz Jim Simeon	Gary		James Peter
Don't know		Judy		Andrew Maria
Unclear answer		Mark Bill Jean		

Table 7.4 suggests that the impression given by the interviewees' comments was justified, and that there was a relationship between an individual's use of CAL and their perception of their colleagues' effective use of computers. Of the six interviewees who felt their colleagues were using computers effectively, five used CAL occasionally or monthly. Of the seven who felt their colleagues were not using computer effectively, five used CAL rarely or not at all.

It might be suggested that this finding simply reflects the fact that both the interviewees and their colleagues were subject to the same resourcing constraints, but this relationship is much more marked than the relationship between CAL use and resourcing (see Section 7.3). However, analysis of the interviewees' comments suggests that there may be a relationship between resourcing, CAL use and colleagues; this was particularly evident amongst those who worked in collaborative departments and who had the higher levels of resourcing. It is proposed that under these (relatively) ideal

conditions, resourcing, CAL use and colleagues interact to allow teachers to move along the obstacle course, as shown in Figure 7.1.

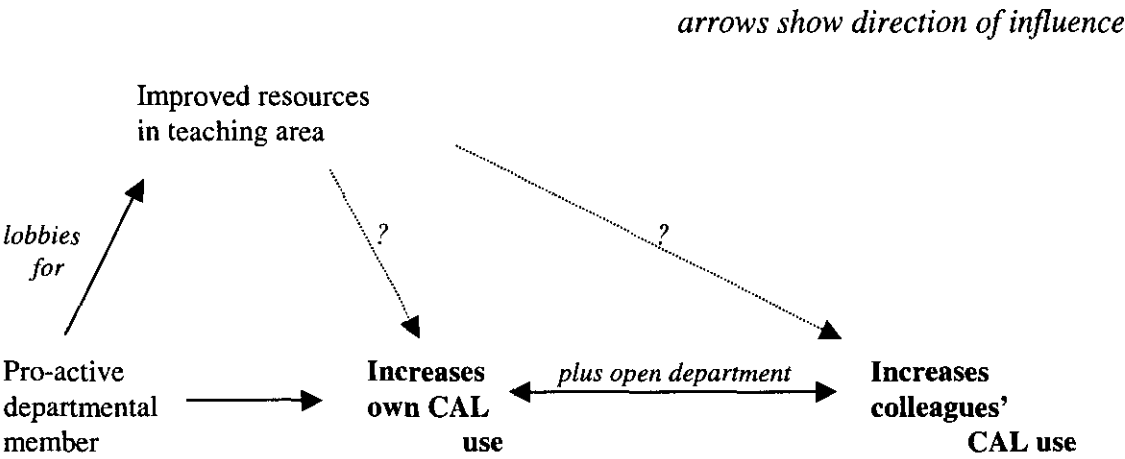


Figure 7.1 Grappling with the obstacle course: the relationship between resourcing and the influence of colleagues

The findings suggest that one individual in the department appeared to take the primary role in introducing the use of CAL. This individual was active in his or her own CAL use and, in some cases, in lobbying for increased resources. When the department was also open to the exchange of ideas, so that teachers knew what was going on in other classrooms, then the CAL use of the pro-active individual appeared to be able to encourage CAL use in their colleagues.

Amongst the interviewees it appeared that:

- Some were pro-active individuals in open departments (e.g. Graham and Phil). They had worked on their own CAL use and pushed hard for increased resources, and their influence had spread to their colleagues.

- Some were (less) pro-active individuals in closed departments (e.g. Andrew and Maria). They had worked on their own CAL use, but did not appear to have pushed for increased resources and their influence had not spread.
- Some were the individuals (e.g. Linda) whose use of CAL had been encouraged by another pro-active individual who had pushed for increased resourcing and increased CAL use.

It was clear in some cases that the initial burden which had been taken on by one individual started to be shared as CAL use spread throughout an “open” department. This was evident, for example, in Linda’s case. Her CAL use had been stimulated by the Head of Department, because he had pushed for increased resources and was “good with the students in the classroom and [made] maximum use of the computers”. Linda in turn had started to actively search for suitable software and ways of using it in the classroom. The sharing of the burden was also evident in Phil and Graham’s cases. For example, Graham had voluntarily taken on the responsibility of managing the hardware, but noted that the situation had developed where “we all find out things for each other”. Where the burden was shared this appeared to result in the pro-active individual’s own CAL use being increased as they moved, with their colleagues, along a “learning curve” (Graham).

To some extent these findings were at odds with Watson’s (1993a) findings (see Section 3.2.1). She also found that pro-active individuals were bearing the burden of implementation of IT in any one department. However, she found that good practice in using IT did not readily diffuse from the pro-active individual to their colleagues. She suggested that this was because the colleagues saw the pro-active individual’s IT use as

being bound up with specific attributes of this individual's character, which they could not emulate.

This situation may have occurred amongst the interviewees, but only in two cases, with James and Peter. These two had the most frequent level of CAL use (monthly and weekly). They were clearly lobbying for increased resources and had a strong awareness of what their colleagues were doing in their classrooms. However, they both felt that their colleagues were not making effective use of CAL.

It was noticeable that these two were also the most technically oriented amongst the interviewee group. James had had a previous career in hardware specifications and used more computer applications at home than any of the other interviewees. He noted in response to the survey question:

Where would you go for help and advice with your use of computers?

"They come to me."

Similarly Peter, although he used fewer applications, demonstrated a strong degree of confidence with computers which emerged both from the survey:

"I am actively developing the use of computers for data capture/analysis and as a resource." (Peter)

and from his follow-up questionnaire (see Section 7.7):

"I have been given remit to embed IT into the science curriculum of my new college."

It may be that James and Peter's computer familiarity allowed them to be very critical of their colleagues' use of CAL. However it may also be that their considerable computer expertise was perceived by their colleagues as the specific attribute which allowed them to use CAL extensively, but which the colleagues could not emulate. It is not possible

to clarify this without further interviews with both the interviewees and their colleagues.

In summary

- Many of the interviewees appeared to be working in relatively closed departments where they were not particularly sure about their colleagues' computer use. These interviewees often concluded that neither they nor their colleagues were using computers effectively, primarily because of poor software or a lack of time. More rarely they concluded that they simply could not tell whether their colleagues were using computers effectively.
- Relatively few felt their colleagues were using computers well. These interviewees generally worked in open and collaborative departments, where resourcing was fairly good, and one or two individuals had initially improved resourcing and motivated use. They also appeared to be using CAL more frequently than those who felt their colleagues were not using computers well.

7.5 Attitude toward biological CAL

The interviewees were asked what features their ideal biological software might have.

Only four did not have immediate answers, (see Table 7.5) suggesting that they had not addressed this issue before, e.g.

“Um, gosh. I don’t think I can pull out - I can’t see an obvious idea.” (Maria)

“It's not something I've given a lot of thought to be honest.” (Jim).

However, only one of these four did not then go on to develop some ideas about what she would like to see, and simply insisted:

“No, honestly, I haven’t got a clue.” (Liz).

While they were answering this question most of the interviewees talked about software they had used, seen or heard about; Table 7.5 also shows whether the comments they made were negative and/or positive, or neutral. As might be expected, the four who did not have an immediate response were recorded as making generally neutral comments. The other 16 interviewees had far more immediate responses to the question, indicating a greater awareness of software.

Table 7.5 Interviewee’s attitudes towards biology software

Interviewee	Did they have an immediate response?	Attitudes towards currently available biology software		
		negative	neutral	positive
Andrew	×		*	
Liz	×		*	
Jim	×		*	
Maria	×		*	
Bruce	✓	*		*
James	✓	*		
Beth	✓			*
Peter	✓	*		
Mark	✓	*		
Phil	✓	*		
Linda	✓	*		*
Simeon	✓	*		
Pam	✓	*		*
Bill	✓		*	
Angela	✓	*		*
Stephen	✓			*
Gary	✓		*	
Jean	✓	*		
Judy	✓	*		*
Graham	✓	*		*

✓ = yes
 × = no

The high level of unsolicited negative comments seemed to show a gap between what the interviewees wanted to see in software, and what they knew to be available. This high level also contrasted with the interviewees' general enthusiasm and/or optimism about the use of computers in education, as revealed in their survey responses (see Table 7.1). Sections 7.5.1 and 7.5.2 outline the positive and negative comments made about biological software. Section 7.5.3 deals with what the interviewees said they would ideally like to see in software.

7.5.1 Criticisms about software

The criticisms fell under a number of categories. These are shown in Table 7.6 and then discussed in turn.

Table 7.6 Criticisms of currently available software

Interviewee	Poor usability	Integration concerns	Pedagogical concerns	Poor availability	No benefit over traditional resources
Bruce	*			*	*
James	*				
Peter			*	*	*
Mark			*	*	*
Phil		*	*		*
Linda		*	*	*	
Simeon			*		*
Pam		*		*	
Angela		*		*	
Jean				*	*
Judy					*
Graham					*

a) Usability

Issues to do with general usability, as opposed to specific classroom usability, were relatively rare, with only two individuals highlighting such problems, e.g.

“I think that we're going through a period in technology when people are getting a bit blown away with technology itself, forgetting about the, sort of, serious need for absolute accessibility.” (James).

b) Integration concerns

Practical concerns about the integration of software into the curriculum, or specific teaching area usability, were mentioned by four of the interviewees, e.g.

“We have got a program which we've put on the network, but it insists that you do the whole test [before getting feedback]. It's the adaptability and the flexibility that I feel we lack ... it needs rewriting.” (Linda)

“[CAL can be] inappropriate for teaching A-level, Access, GCSE syllabuses – I've got to do it fast, really, really fast.” (Pam)

In one case the interviewee reflected on recent experience:

“I thought - oh great, with spreadsheets and so on - I'll get them to put in their data and draw a graph, so I had one computer at that time so somebody did it, and then it was done, so everybody photocopied it and put it in their book! And I thought ha! so 20 minutes of graph drawing can be wiped out. So there are times when it can actually detract from what you are trying to teach, and it can make what used to be a sort-of useful exercise shrink away to nothing.” (Phil)

Phil's comment touched on three interrelated problem areas with respect to classroom CAL use, namely:

- (i) how resourcing levels can constrain successful CAL implementation
- (ii) how a teacher might need to change already effective classroom practice in order to use the CAL

(iii) whether the software is pedagogically valuable enough to warrant such changes.

These issues arise extensively in Chapters Eight and Nine.

c) Pedagogical concerns

Pedagogical concerns were mentioned by five interviewees. There was a sense of frustration evident about currently available programs which were seen as failing to exploit the computer's potential to enhance students' learning. In general such programs were seen as lacking interactivity, and therefore lacking engagement, a sense of real purpose, and an ability to respond to students' needs, e.g.

"The presentation is very good on most of the commercially available stuff, you can't fault that, but the actual power to engage the students beyond the first five minutes is very limited ... you can't expect things to be ideal instantly, but there seems to be, I don't know, an infatuation with the technology rather than the learning." (Simeon)

"I still remain to be impressed by the CAL stuff. [When a human teacher is] going through a topic, there are so many other things that the students will ask, which are quite unrelated [and to which most programs cannot respond] ... different things come up for different students." (Mark)

"I think it's very bad actually, there's a lot of software out there [in which] there's no interaction because you can't use it as a tool, other than gathering information, which is not primarily what I want the students to be using them in here for, because that's not what you use them for outside in industry." (Peter).

d) Availability of suitable biological software

Seven of the interviewees commented on the lack of suitable biological software; for the most part this "suitability" related to the subject area and level, rather than usability, integration or pedagogy, e.g.

"The limitations on software don't seem to be the money, they seem to be availability of suitable packages at the moment." (Linda)

"... and to be honest there's not a great deal available in the sciences, as you probably

know. ... I use the web, but it's more software packages that there seems to be a dearth of." (Angela)

Comments about the poor availability of biological software for A-level or equivalent were voiced strongly throughout the survey and both sets of interviews.

e) No benefit over traditional resources

The major complaint made about currently available software was that it often failed to do anything which could not be done using traditional resources; once again there was a sense of frustration that software was failing to exploit the computer's potential. For the most part the concerns expressed under this category were about programs which were seen as essentially book-like, e.g.

"There's a lot of software that, although it's very active in some ways, it's still just active text. It's still ultimately you're turning a page on a book, electronically."
(Graham)

"I looked at some sort of simulation stuff [which] I didn't like because it seemed to be too much like a book." (Phil)

"I think a lot of the general stuff I see is just essentially books on CDs." (Simeon).

However, one interviewee highlighted a slightly different perspective:

"I'm not so keen on textbooks on screen, you know ... I don't see any advantage putting it on a screen, it just strains your eyes [although] maybe my preference is for the book based things, but a students' preference is for up on the screen." (Judy)

Complaints about software concerning usability, integration and pedagogy resurfaced during the Second Interviews. Complaints about software showing no benefit over traditional resources also featured, but to a different degree (see Section 8.3). Complaints about the lack of availability of software for A-level or equivalent were rare in the Second Interviews, because the interviewees were reviewing software which was specifically chosen to be appropriate for this level; however, it is worth stressing here

that the researcher also had problems in finding suitable programs when selecting the software pool (see Section 6.1.2).

7.5.2 Positive comments about software

The negative comments featured in the previous section fell into fairly well defined categories. This was not so much the case with the positive comments, which reflected a more variable focus amongst the interviewees; this variability was also seen in the Second Interviews (see Section 8.3). Seven of the interviewees expressed positive comments about either specific pieces of software they had seen, or the general capabilities of software. They saw software as being valuable in the following ways:

a) illustrating concepts

“I know some of the BBC [programs] have got stuff on the Bohr effect which is useful, because that's a difficult concept for [students] to understand.” (Angela)

b) developing problem solving skills

“You can change the way the students answer, [and therefore change the approach that they use in order to] tackle the problems.” (Graham)

c) developing organisational skills

“[Students] can use the basis to create something for [themselves] so it's tailored to [their] needs ... there's a lot of scope for students getting involved in doing web-sites.” (Graham)

d) providing useful information sources

“For me it would be I think getting into, via the Internet, things which aren't available in the college, getting into library systems. It would be getting into things which are very much more up to date.” (Judy)

e) controlling experiments

“I guess I would be looking at things which enabled the interfacing and the long term

experiments.” (Judy)

f) simulating experiments which were difficult to perform

“They're good ... if you're doing something like a potometer, which sometimes you just can't get the air excluded from, and so you end up with no results, and so you can pop in something like that then you can generate a set of results.” (Pam)

g) analysing data

“There've been some very good programs that link, particularly to biology for the BBC computer, so looking directly at ecology, doing things like chi-squared, spearman rank ... ideally so you could use them as a spread-sheet and then put them in and get kite diagrams or whatever graphical representation you want out at the end.” (Linda)

These comments about the benefits of software reflected those made in the survey responses (see Section 4.3.6); it was noticeable that they were all concerned with features of software not found in traditional resources. It was also noticeable that they were often illustrated with reference to HE programs, e.g.

“[I would like to see something which is] interactive in the fact that the student could actually change factors to see what was happening and actually be asked to think about what was occurring ... I know there are packages around like that [from when] I used to do a bit of teaching at University.” (Beth)

“A lot of these packages are designed [so] that they try to present [information] from example to outcome rather than the other way around, ... [I notice this] especially in my HND, degree and MSc [teaching].” (Stephen).

Overall, the interview comments and the researcher's experience in collating the software pool suggested that a number of biological software packages designed for HE had features which FE biologists were looking for but not finding.

7.5.3 What they wanted to see

Almost all the interviewees stressed that they wanted to find programs which had a high

degree of interactivity. This was generally between the user and computer, e.g.

“[I’d like to see a program that’s] more interactive, that’s not simply the holder of limited amount of information that you click on and get a brief description of something.” (Peter)

In one case, however, the interviewee stressed the importance of interaction between the user and other individuals, e.g.

“It would have to have tutor input, a lot of it, and interaction with other students and so on, because I’ve heard that these computer learning packages that they’ve used in industry have fallen flat in many cases, not because of the quality, but because the people using them get bored after a time of just tapping into the screen.” (Bruce).

Only one interviewee (Andrew) described his ideal software program in terms of how it would fit in with his teaching:

“[The software] can have organ systems and ... anatomy ... then what you can do, is you, you can give some theory out, you can give some gapped handouts out and then you can allow the students to have access, to work through at their own pace.”
(Andrew)

This perspective was absent from all the other interviewees’ accounts, even if they had previously mentioned problems with software integration. However, it emerged strongly during the Second Interviews.

The interviewees generally concentrated on the content of the program, although occasional comments were made more specifically about the interface, e.g.

“It would have to be very interactive with students to keep their attention ... It’s nice if it’s a bit jazzy, but it should be very clear and explicit.” (Jim).

However, for the most part the interviewees concentrated on the content of the program and how the software should exploit the ability of the computer to perform certain tasks, thereby adding to the students’ understanding, skills or knowledge. Very little was

mentioned here about the need for a program to have entertainment or engagement potential (for rare exceptions, see Jim and Bruce's comments, above), even though absence of this came up in the negative comments about software, and featured heavily in the Second Interviews.

Table 7.7 shows the range of applications which the interviewees wanted to see in their ideal software.

Table 7.7 Range of ideal software applications

Interviewee	Demonstrating movement	Experimental interfacing	Revision or reinforcement	Data analysis	Providing a different way of learning	Practising skills	Performing simulations	Accessing and manipulating information
Andrew			*					
Bruce						*		*
James								*
Beth			*		?		*	
Jim								
Maria				*		*		
Peter				*				*
Mark		*						*
Phil					*		*	
Linda				*				
Simeon								
Pam		*		*		*	*	*
Bill	*						*	
Angela			*		*	*	*	
Stephen							*	
Gary						*		*
Jean	*						*	*
Judy		*			*			*
Graham						*		*

? = unclear

Each of the categories shown in Table 7.7 is now addressed, briefly, in turn.

a) Demonstrating movement

Two of the interviewees stressed the importance of software which could demonstrate movement, e.g.

“[I'd like to see software dealing] with the science of fish - the sort of physiology - shown fairly simply, but moving, you know, how fish swim and how the swimbladder works - so the basic physiology - that would probably come over well on software.”

(Jean)

“Um I'd like the package to show movement, which you can't get from a book, obviously. And, um, biology is full of movement - ions across membrane and electrical movements.” (Bill).

b) Experimental interfacing

Only three individuals mentioned this when discussing their ideal software, usually very much in passing, e.g.

“I guess I would be looking at things which enabled the interfacing and the long term experiments.” (Judy)

Interfacing was seen as particularly valuable in the survey responses (see Section 4.3.6).

Since nearly half the interviewee group actually used interfacing in their teaching it may be that it did not feature heavily in their ideal software because they already had programs which performed adequately.

c) Reinforcement or revision

Only three interviewees talked about software as being useful on these grounds:

“I want to make sure that they are learning, and I think I can only do that by teaching myself – the computer is reinforcement if anything.” (Beth)

“... and also you can provide ... alternative work so you can have some groups doing, you know, looking down microscopes, various different things, looking at

models, ... then you've got a cycle going - you've got some going through the computer package and, just a very good revision.” (Andrew).

This relative absence of focus on reinforcement and revision contrasted strongly with the findings of the Second Interviews.

d) Data analysis

Data analysis also featured strongly in the survey responses (see Section 4.3.6), but only four individuals mentioned it here, possibly because, as with the experimental interfacing, most of the interviewees already had access to data analysis software (generally Excel). Consequently data analysis was mentioned very much in passing, e.g.

“[CAL would be useful for] putting your results in and having the plots come out and doing the statistical test on them.”(Pam)

or with emphasis only when something was needed which standard data analysis programs did not do so well, e.g.

“[I'd like to have something which could do] things like chi-squared, spearman rank, all the other tests ... ideally so you could use them as a spread-sheet and then put them in and get kite diagrams or whatever graphical representation you want out at the end. The problem at the moment is that, say you use something linked up to Excel, the formulae on the Excel and the formulae that you'd calculate by hand do not match.” (Linda).

e) Providing a different way of learning

This was mentioned by four interviewees, e.g.

“I often say to [students] I'm going to give you one interpretation [but you should look for others] because one of them will click with you, whereas the others might not. And that's the beauty of television programs because it gives another interpretation, and that would be the benefit of a computer program.” (Angela).

However it only received particular emphasis in one case:

“The overarching thing [in my teaching] ... is getting the learners to be independent and ... recognising that people learn in different ways ... So I would be looking for [packages] which were providing opportunities for people to learn in different ways.” (Judy).

f) Practising skills

Six interviewees stressed the value of software that enabled students to practise skills.

In two cases, these were specific problem-solving skills, e.g.

“[It would be useful to have something which gives students] practice they need in analysing graphs and so on.” (Bruce).

In the other four cases they were more general skills, e.g.

“[It would be useful to have software] that would backup difficult concepts and give [students] the chance to backup and practice and develop skills.” (Angela)

“[The ideal software] would be recursive – [it would say to the students] you’ve made a mistake, this would be the right answer, go back and try again.” (Gary).

g) Performing simulations

This was the second most common requirement amongst the interview group. The interviewees wanted to see simulations used in a number of ways. For example:

(i) in order to mimic what would happen if an experiment were carried out:

“[Ideally I would have] software which would come up with results ... and then the student would have to manipulate the results for themselves, rather than have the computer do it for them.” (Phil)

(ii) or to combine this with other features:

“[I’d like to use] something that also you’re able to load data into and perhaps do a comparison of actual data with simulations and analyse on the computer.” (Peter)

“The other one would be the absolutely classic experiments you do within the A-level syllabus ... something like that that gets them exercising the method, gets them thinking about safety factors, gets them designing it properly.” (Pam)

(iii) or to model a process or system:

“[I’d like to see] an ecology simulation where you make decisions and you see what the outcome could be.” (Bill)

“[it should be] interactive in the fact that the student could actually change factors to see what was happening and actually be asked to think about what was occurring rather than – just press this next and see what happens to the diagram.” (Beth)

h) Accessing and manipulating information

This was the most common category, with nine of the interviewees stressing that they would find such software valuable in terms of:

(i) up to date information access:

“Getting into, via the Internet, things which aren't available in the college.” (Judy)

(ii) accessing a large amount of interactive information:

“A nice computer learning package would be to start at the beginning of the course and go through to the end of the course, referencing to text books, practical work and so on, but at the same time making sure the student has to dig for the facts and the information and to get the practice in applying the knowledge they had to analysing graphs and so on.” (Bruce)

(iii) *allowing manipulation of how information is presented:*

“I think the ideal [package] is something like the old expert systems idea the old learning shell, where [students] can use the basis to create something [themselves] so it's tailored to [their] needs so [they] actually have the slots and [they] put in the work.” (Graham).

Two of the answers given under this section bore a strong similarity to each other:

“So say you're looking at a part of say the GNVQ syllabus, it would be useful to have a software package that incorporates context and uses data from real life situations and allows you to work through that and change parameters. There isn't anything like that at the moment.” (Peter)

“So the idea that we've got is something like, for GNVQ, something for the unit on health and disease, you have to use secondary data to analyse somebody's health in some way. So you talk about ECGs and X-rays and whatever, and that struck me as a definite possibility, that you could have six different patients and you could call up their ECGs and their blood cell counts, either as a print out or you could even have like a haemocytometer idea. You could have X-rays built into it.” (Mark).

Here both Mark and Steve were looking at a very specific teaching situation on a relatively new course (GNVQ) and exploring how the computer could be used to overcome the specific difficulties they had encountered. This type of approach was also evident in Pam's description of her ideal CAL, which she saw as overcoming some of the problems involved in taking students on a field trip. Pam's ideal CAL was described in the pilot study (see Section 6.3.3) and was related to Draper's (1998) concept of “niche-based success” in CAL.

It was noticeable that where the interviewees were talking about:

- a) using CAL to overcome specific difficulties, e.g. with Mark and Peter's GNVQ course, or Pam's field trip
- b) using CAL in fairly creative ways, e.g. with Graham's construction of web-sites with special needs students
- c) using CAL to increase student independence e.g. with Judy's ideas for use in resource centres

they were considering the use of the software outside the A-level or equivalent, classroom-based sessions which were the norm for this group of interviewees.

Therefore it may be that the typical A-level or equivalent set-up mediates against valuable types of CAL use; this point is returned to in Chapter Eight.

In summary

- There was a strong sense amongst the interviewees that the availability of biological software for A-level or equivalent courses was poor.
- Where software was available it was often seen as lacking interactivity and representing no benefit over traditional resources.
- Most interviewees had a strong sense of what features their ideal software would have.
- They were generally enthusiastic about software which was interactive and could be used in ways in which traditional resources could not, e.g. simulations, interactive skills development, information access and manipulation.
- There was some evidence that the typical A-level or equivalent, classroom-based set up might not encourage valuable types of CAL use.

7.6 Conceptions of teaching and learning

The structure of the relevant questions for this section, and the interpretation of the answers derived from Prosser, Trigwell and Taylor's (1994) phenomenographic study. The study was outlined in Section 5.5.1 and illustrated in more depth in Section 6.2.4, where the pilot study group members were classified. Section 7.6 is sub-divided as follows:

7.6.1 gives additional methodological details

7.6.2 classifies the main study group, giving illustrative quotes

7.6.3 relates the interviewees' conceptions of teaching and learning to their attitudes to, and use of, CAL.

7.6.1 Additional methodological details

As with the pilot study classifications, the main study classifications were repeated by the researcher on a number of occasions until they were constant. In order to check the validity of the classifications, just over a third (seven) of the interviewees' classifications were blind-checked by another researcher. This second researcher carried out his classification using the extracted parts of the texts which had been prepared by the first researcher, and using Section 6.3.4 of the pilot study chapter as a reference. There was only one case in which the two researchers' classifications differed, and this was a case where the original researcher had been unable to decide on a clear classification¹. Overall it was felt that the use of the classification scheme had been fairly consistent and gave no cause for concern.

7.6.2 Interviewees' classifications for teaching and learning

Tables 6.2 and 6.3, in Chapter Six summarised the Prosser, Trigwell and Taylor (1994) scheme for classifying conceptions of teaching and learning. These tables are reproduced in this section in order to aid clarity. In each case the tables are followed by sample quotes from the 14 interviewees who were not involved in the pilot study in order to provide further illustration of the use of the framework.

¹ This was with Andrew's classification for teaching, which the first researcher had recorded C/D, and the second researcher recorded C.

Table 6.2 Conceptions of learning (reproduced from Chapter Six)

Outcome of learning	Focus on learning as...	Conception
it satisfies external demands	accumulating more information/skills	A
	acquiring concepts and relations between them to extend prior knowledge	B
it satisfies internal demands	acquiring concepts and relations between them to extend prior knowledge	C
	a personal conceptual development	D
	a personal conceptual change	E

(adapted from Prosser, Trigwell and Taylor, 1994)

The classifications range from teacher-centred (*A*) to more student-centred (*E*) and the individual teachers were classified according to the most student-centred ideas they expressed.

Only three teachers, Bill, Liz and Pam, described learning as something which satisfies external demands; these teachers were therefore classified as holding conception *A* or *B* for learning. Bill was classified as holding conception *A* because of his focus on learning as the accumulation of information:

“[Learning] means that if I ask the question – how does the heart work - then [the students] would be able to tell me ... [and] they know pretty well that they've learnt something if they can answer.” (Bill, *conception A*).

Liz was classified as holding conception *B*, because although she still focused on learning as external:

How would the students know they had learned?

“I hope from assignment work, so they get the feedback, from written pieces of work, tests”

she also focused on learning as the acquisition of concepts and relations between them:

“With Access [students] you’re trying to give them experiences, you’re trying to help them see a whole wider thing ... that hopefully they can build on in some way.” (Liz, *conception B*).

Seventeen of the interviewees stressed that students should know for themselves whether they had learned; this meant that they were classified *conception C* or above. Sometimes this seemed to be an almost automatic assumption:

How would the student know if they had learned something?

“What, from me? Or how would they know within themselves?” (Jean, *conception C*).

However, quite often the interviewees stressed the importance of internal awareness, but also noted that this was a learning skill which many of their students did not have:

“[Students suddenly see] that someone has a completely different world view. [If they don't then] you're dealing with a student who is conceptually not ready for the course that they're on. They don't know that there are fundamental building blocks missing.” (Judy, *conception D*).

This perspective was not stressed in Prosser, Trigwell and Taylors' (1994) account, possibly because they were dealing with teachers of HE students, rather than teachers of (generally) less academically sophisticated FE students.

Conceptions *C*, *D* and *E* are distinguished from each other by the teachers' focus on learning as, respectively, the acquisition of concepts, a personal conceptual development, or a personal conceptual change. Interviewees who were classified as holding *conception C* focused on the acquisition of concepts:

“[Learning is] adding to your general knowledge of facts and concepts [and] understanding how they all link together in a sort of broad overview” (Jim, *conception C*)

Interviewees who were classified as holding conceptions *D* or *E* expressed the view that learning was concerned with the learner's personal conceptual development:

How would you know if a student had learned something?

“If they've actually understood what's going on and done something with it in their own brain then you should be able to spot that too, and that takes experience.” (Phil, *conception C/D*)

or their personal conceptual change:

How would you know if a student had learned something?

“I know this is getting into a really hippy thing, but they have a far more holistic approach to knowledge ... they start to link the whole thing up, you know, and they make their connections to outside life ... They suddenly start asking certain questions about things around them - it's when that *light* goes on in a student, it's then that you know that certain things have been achieved.” (Graham, *conception E*).

The final classifications for both learning and teaching are shown in Table 7.8.

Table 6.3 outlines the conceptions of teaching according to the Prosser, Trigwell and Taylor (1994) scheme. This is, again, followed by sample quotes from the 14 interviewees who were not involved in the pilot study.

Table 6.3 Conceptions of Teaching (reproduced from Chapter Six)

Prior knowledge	Focus of the teaching	How the teachers see their role	Conception
no focus on this	on concepts as outlined in the syllabus or textbook	as transmitters of information based on these concepts	A
	on the teacher's own concepts	as transmitters of information based on these concepts	B
focus on this	on concepts as outlined in the syllabus or textbook	as helping students to acquire these concepts and relations between them	C
	on the teacher's own concepts	as helping students to acquire these concepts and relations between them	D
	on students' world view or conceptions of the subject matter	as helping students develop their conceptions	E
	on students' world view or conceptions of the subject matter	as helping students change their conceptions	F

(adapted from Prosser, Trigwell and Taylor, 1994)

The six conceptions of teaching also lie on a continuum from teacher-centred (A) to more student-centred (F).

Conceptions A and B are characterised by a lack of focus on students' prior

knowledge, and by the teachers' view of themselves as transmitters of concepts:

"[teaching is] talking to the students or explaining concepts ... doing practical exercises, and problems ... and also work-sheets." (Angela, *conception A*).

Teachers holding conception *C* for teaching also focus on concepts, but see their role as helping students to acquire these concepts, while bearing in mind the students' prior knowledge:

"So a lot of the teaching, it's not just factual, it's getting them to understand what the hell is going on there, the concepts behind it ... and it's cumulative." (Beth, *conception C*).

Teachers holding conception *D* for teaching also focus on the students' prior knowledge, but differ from those holding conception *C* in that they focus less on syllabus or textbook concepts and more on their own concepts:

"I suppose [the students] build up ideas in shells and link them together ... I spend a lot of time asking them to write down information and look for trends and then I guide them through it looking for other areas of trends that they might not have picked out ... I also try to be eclectic and point them to lots of different areas where what they're doing fits [in or] overlaps." (Peter, *conception D*)

"I think [the students] should understand something and have enthusiasm for it. And also every so often have these kicks when they suddenly realise that something is really very clever. Like yesterday we were talking about the placenta, and there was a real Gestalt at that, .. it was just – oo, isn't that clever. It is Gestalt, because you're providing different bits of information, and all of a sudden the whole thing comes together and it becomes much more than the individual parts." (Mark, *conception D*).

Teachers holding the most student-centred conceptions have a strong focus on the importance of prior knowledge:

"[Students often have] an inability to understand that you can't set about gaining that information unless you get a good picture or framework about where you're going to store that information and how you're going to use that information, i.e. how you sit in

relation to the area you want to study or the things you want to look at.” (Graham, *conception F*).

They also have a focus on the students’ perspectives on learning:

“The temptation is always to access [students] into what is *your* way of learning, and it's quite hard, I think, to remember the alternatives.” (Judy, *conception E*)

“As an adult [learner] you're not just trying to complete the exercises that the teacher sets, you're trying to find out if you know something and you think around it.” (Phil, *conception D/E*).

Teachers holding *conception E* see their role as helping students to *develop* their own conceptions of the subject matter:

“The teachers’ role is one of getting people eventually to a point of being fairly independent, and exposing students to a very broad range of different material, different ways of looking at things .. [so they can] access the information and put it together in creative ways.” (Judy, *conception E*).

Teachers holding *conception F* see their role as helping students to *change* their own conceptions of the subject matter:

The student doesn’t have to realise instantly that they have changed. Some of the things you hope will be a gradual process. And sometimes you get some indication of that when they come several years later and say – what we learned here meant that we could progress on.” (Linda, *conception F*)

“[Learning] is very much a matter of factual recall to start with, and as time progresses and things sink in then anomalies arise and then that process continues into the generation de novo of opinion based on that factual information and the questioning of that dogma.” (Gary, *conception F*)

“And I think for learning, and it goes back to the teaching thing, you’re trying to create the atmosphere that means that the penny will drop, and people will realise that sometimes there are changes, it’s not just a simple thing of sitting down and thinking – why is this thing not going into my head.” (Graham, *conception F*).

relation to the area you want to study or the things you want to look at.” (Graham, *conception F*).

They also have a focus on the students’ perspectives on learning:

“The temptation is always to access [students] into what is *your* way of learning, and it's quite hard, I think, to remember the alternatives.” (Judy, *conception E*)

“As an adult [learner] you're not just trying to complete the exercises that the teacher sets, you're trying to find out if you know something and you think around it.” (Phil, *conception D/E*).

Teachers holding conception *E* see their role as helping students to *develop* their own conceptions of the subject matter:

“The teachers’ role is one of getting people eventually to a point of being fairly independent, and exposing students to a very broad range of different material, different ways of looking at things .. [so they can] access the information and put it together in creative ways.” (Judy, *conception E*).

Teachers holding conception *F* see their role as helping students to *change* their own conceptions of the subject matter:

The student doesn’t have to realise instantly that they have changed. Some of the things you hope will be a gradual process. And sometimes you get some indication of that when they come several years later and say – what we learned here meant that we could progress on.” (Linda, *conception F*)

“[Learning] is very much a matter of factual recall to start with, and as time progresses and things sink in then anomalies arise and then that process continues into the generation de novo of opinion based on that factual information and the questioning of that dogma.” (Gary, *conception F*)

“And I think for learning, and it goes back to the teaching thing, you’re trying to create the atmosphere that means that the penny will drop, and people will realise that sometimes there are changes, it’s not just a simple thing of sitting down and thinking – why is this thing not going into my head.” (Graham, *conception F*).

The final classifications for both learning and teaching are shown in Table 7.8.

Table 7.8 Interviewee classifications for conceptions of learning and teaching

Interviewee	Conception of learning	Conception of teaching
Andrew	C	C/D
Bruce	E	F
James	C	C/D
Liz	B	C
Beth	C	C
Jim	C	C
Maria	C	A
Peter	C/D	D
Mark	C/D	D
Phil	C/D	D/E
Linda	E	F
Simeon	D	E
Pam	B?	C?
Bill	A	B
Angela	C	A
Stephen	C	D
Gary	E	F
Jean	C	C
Judy	D	E
Graham	E	F

? = Pam’s classification is uncertain; the reasons for this were given in Section 6.2.4

As can be seen from Table 7.8, some of the interviewees could not be classified into one category and were therefore recorded in two, for example, D/E. Similar difficulties in classification were recorded in Prosser, Trigwell and Taylor's (1994) account (see Section 5.5.1). In summary the numbers of interviewees in each category were:

Category	Learning	Teaching
A	1	2
B	2	1
C	8	5
C/D	3	2
D	2	3
D/E		1
E	4	
F		4

As noted in the pilot study, the relative absence of *As* and *Bs* may reflect recent student-centred changes in FE, and the interviewees' likely familiarity with student-centred terminology. This was borne out by the occasional comment, such as:

“How would I know if a student had learned something? I could give you the set answers I would give somebody coming on an audit?” (Graham).

This raises some concerns about how far the classifications can then be said to reflect the interviewees' real student- or teacher-centredness. However, the interviewees' assessment of software (see Section 8.6) and classroom dynamics (see Section 9.4) were generally in line with their classifications. This coherence between what the interviewees said under different situations and how they taught, gives confidence to the findings described in this section. It suggests that the interviewees' classifications were able to reveal some of their convictions about education, rather than just reflecting the ways in which they talked about it.

7.6.3 *Conceptions of teaching, learning and CAL*

This section examines the relationship between the teachers' philosophies of teaching and learning, and their attitudes towards and use of CAL.

In Table 7.9 the interviewees have been sorted into five groups based on their philosophies of education, starting with the most teacher-centred. These groupings are shown against their current CAL usage. Also shown are three of the eight ideal CAL features (as shown in Table 7.7). The rest of the eight features are not shown, as these are the only three which revealed any pattern when placed against the interviewees' conceptions of teaching and learning.

Table 7.9 Educational philosophies, CAL use and ideal CAL

Teacher	Conceptions		CAL use	Ideal software involves		
	L	T		Practising skills	Simulations	Accessing / manipulating information
Bill	A	B	rare		*	
Angela	C	A	rare	*	*	
Maria	C	A	monthly	*		
Pam	B?	C?	n/a	*	*	*
Liz	B	C	none			
Jean	C	C	rare		*	*
Jim	C	C	none			
Beth	C	C	monthly		*	
James	C	C/D	monthly			*
Andrew	C	C/D	monthly			
Stephen	C	D	occasional		*	
Peter	C/D	D	weekly			*
Mark	C/D	D	rare			*
Phil	C/D	D/E	occasional		*	
Simeon	D	E	none			
Judy	D	E	rare			*
Gary	E	F	rare	*		*
Graham	E	F	monthly	*		*
Linda	E	F	occasional			
Bruce	E	F	none	*		*

L = conception of learning
T = conception of teaching

As can be seen from the table there is no indication that a more or less student-centred perspective had an influence on the frequency with which the interviewees used CAL. This contrasts with the literature (e.g. Loveless, 1996; Hodas, 1993; Hannafin and Freeman, 1995) which, firstly, suggests that many teachers resist using software because they are fixed in teacher-centred modes, and secondly, implies that the use of software is likely to be encouraged and/or accompanied by a shift to a more student-centred perspective.

There is, however, a pattern that emerges from the “ideal CAL” categories, with simulations featuring more in the teacher-centred range and information access and manipulation featuring more in the student-centred range. It is not clear why this should be so with simulations, but it certainly makes sense with respect to the information access category, where the teachers often stressed a student-centred use, e.g.

“I think the ideal [package] is something like the old expert systems idea the old learning shell, where [students] can use the basis to create something [themselves] so it's tailored to [their] needs so [they] actually have the slots and [they] put in the work.”
(Graham)

“The overarching thing [in my teaching] ... is getting the learners to be independent and .. recognising that people learn in different ways ... So I would be looking for [packages] which were providing opportunities for people to learn in different ways.”
(Judy).

There were insufficient numbers in the other categories for any patterns to emerge; however, it is interesting to note that skills practice appeared equally in the most teacher-centred and most student-centred groups, and nowhere else.

The final table in this section, Table 7.10, shows the relationship between the individuals' classifications for teaching and learning and their overall attitudes towards

currently available software (as outlined in Section 7.5).

Table 7.10 Conceptions of teaching and learning, and attitudes towards currently available CAL

Teacher	Conception		Attitude towards currently available CAL		
	L	T	Negative	Neutral	Positive
Bill	A	B		*	
Angela	C	A	*		*
Maria	C	A		*	
Pam	B?	C?	*		*
Liz	B	C		*	
Jean	C	C	*		
Jim	C	C		*	
Beth	C	C			*
James	C	C/D	*		
Andrew	C	C/D		*	
Stephen	C	D			*
Peter	C/D	D	*		
Mark	C/D	D	*		
Phil	C/D	D/E	*		
Simeon	D	E	*		
Judy	D	E	*		
Gary	E	F		*	
Graham	E	F	*		*
Linda	E	F	*		*
Bruce	E	F	*		*

L = conception of learning

T = conception of teaching

It seems from this table that the shift from teacher-centred to student-centred conceptions was associated with an increase in the negative comments made about currently available CAL; this was also evident in the Second Interviews. The

most student-centred group, however, also showed an increase in the positive comments made. It is possible therefore that the more student-centred teachers were simply more expansive in general and likely to exhibit a range of views, which may be both teacher-centred and student-centred (and therefore recorded under the Prosser et al (1994) scheme as student-centred), and more positive and negative about CAL. However, the *types* of complaint made by the more student-centred teachers had a degree of coherence in terms of their stress on pedagogy which suggested that the more student-centred teachers' objections were related to their educational philosophies. This was particularly evident in the teachers' comments about the lack of interactivity evident in many currently available programs, e.g.

"[My ideal software] would have to have ... tutor input ... and interaction with other students. [Various packages] have fallen flat [because] people using them get bored after a time of just tapping into a screen." (Bruce, *conceptions E and F*)

"I still remain to be impressed by the CAL stuff. [When a human teacher is] going through a topic, there are so many other things that the students will ask, which are quite unrelated [and to which most programs cannot respond] ... different things come up for different students." (Mark, *conceptions C/D and D*).

In summary

- The Prosser Trigwell and Taylor (1994) scheme provided, in general, a useful and reliable way of classifying the teachers' philosophies of teaching and learning.
- The most teacher-centred categories (A and B) were not strongly represented, possibly because FE has undergone a number of student-centred changes in recent years.
- There did not appear to be a straightforward relationship between the interviewees' degree of student-centredness and their use of CAL.

- There appeared to be some relationship between the interviewees' degree of student-centredness and the type of software they saw as being ideal, with the more student-centred teachers favouring information and access software, and the more teacher-centred teachers favouring simulations.
- There appeared to be some relationship between an increase in student-centredness and an increasingly critical attitude towards currently available software.

7.7 Follow-up questionnaire

After the interviews and observations had been completed a follow-up questionnaire was distributed to 17 of the 20 interviewees (the other three were known to have left their colleges). This was because it was felt that the research was being carried out at, potentially, a time of great change for FE teachers with respect to their use of educational technology. The QUILT programme was seen as the stimulus for this change (see Section 1.1.2), and it was felt appropriate to see what impact the programme had had on the interviewees' computer use and computer use environment (e.g. resourcing) before concluding the thesis field work. A copy of the follow-up questionnaire can be found in Appendix Seven.

The follow-up questionnaire was brief, consisting of one side only. It aimed to assess whether:

- a) the interviewees' had changed the frequency with which they used CAL, and/or the type of CAL they were using
- b) they had had any further IT training, and if so, in what areas
- c) their teaching area resourcing had changed, and if so, how

d) they felt that their line managers were supportive of their use of learning technologies, and whether this had changed over the previous two years.

Fifteen responses were received, and the findings are described in the following four sections.

7.7.1 Types and frequency of CAL use

With respect to the different types of application the interviewees had started to use, two had increased their use of interfacing, and six had increased their use of the Internet.

Frequency of CAL use had stayed the same in eight of the 15 cases. It had decreased in two cases because of decrease in equipment and funding, and had increased in six cases. One of the interviewees recorded both an increase and decrease; following the interview her use had decreased because the science computer laboratory had been given to the special needs department:

“[So] it decreased last year, but then we gained access to a laptop and projector and movable computer!” (Linda)

Increased hardware resourcing was seen as the main stimulus for an increase in CAL use by four of the interviewees; this was particularly the case where the individuals had previously been in the *Lowest Resources Group*. Two mentioned that their CAL use had been stimulated by improvements in available software, and another two recorded that their increase in CAL use was due to:

“[an increase in my own] familiarity with a range of software products” (Simeon) and

“[the fact that I] realised that it has been possible to use computers in class.” (Jim).

These last two were the least experienced teachers amongst the interviewee group,

having been in teaching only two and one years respectively at the time of the survey.

Jim put his realisation down to his involvement in the research described here:

“[The interview and observation] sessions made me think about how to use computers educationally.” (Jim).

In their responses to the questions about changes in CAL use, the teachers clearly identified the importance of both hardware and software resourcing; decreased CAL use was explained by decreased hardware resources, and increased CAL use was explained by increased resources, both in terms of software and, more particularly, in terms of hardware. These findings agree with the findings of the survey (see Chapter Four) and much of the literature on teachers’ use of CAL (see Chapters Two and Three).

However, they were not strongly supported by the findings from the First Interviews (see Section 7.3). It was suggested in Section 7.3 that above a minimal level, the direct effect of resourcing on frequency of CAL use was obscured by other factors. In the light of the findings from the follow-up questionnaire it seems likely that the influence of resourcing is best investigated using longitudinal studies, where *changes* in resourcing will allow this influence to be identified more clearly, and where the participants are asked to identify directly the consequences of these changes.

7.7.2 *Training*

Ten of the interviewees had had no further IT training, e.g.

“Development has been self-driven” (Simeon).

One recorded that he had training sessions coming up, and four recorded that they had had training over the previous two years in, variously, Windows 95/98, e-mail, PowerPoint and the use of spreadsheets in biology teaching. The low rate of IT training

was surprising, bearing in mind that this was a particular focus of the QUILT programme.

7.7.3 Teaching area resourcing

Eight respondents recorded no increase in their resourcing, and two indicated that there had been a decrease because of re-allocation of resources between departments. Five recorded an increase as follows.

Table 7.11 Improvements in interviewees’ resourcing levels

Interviewee	Resourcing at the time of the survey	New resources
Simeon	effectively none	“Small but effective science computing room close to the labs.”
Pam	effectively none	1 moveable Pentium
Andrew	1 BBC on trolley	1 moveable Pentium, 1 laptop plus projector
Bruce	1 286 in science corridor	“Computer based full time in biology prep room with printer for staff use”
Peter	3 roving multimedia machines	Networked PC in each lab

Once again the issue of centralised computing facilities came up unsolicited, with two of the interviewees noting under ‘any other comments’:

“Cross-college provision has increased significantly but timetabling constraints mean you can’t use rooms on a one-off basis easily.” (Linda)

“The college as a whole has had a considerable increase in IT equipment which are (sic) available for use by students and staff – these are centralised in one building and are about 5 minutes walk from the biology section. They are therefore not useful from

a CAL point of view.” (James).

The lack of a dramatic increase in classroom based computer resourcing was not surprising, even bearing in mind the aim of the QUILT programme to increase the general use of information and learning technology (ILT). As noted in Chapter One the push within FE has been towards increasing curriculum delivery in resource centres (Gray and Warrender, 1995); Linda and James’s comments (above) suggest their colleges have followed this line, rather than making significant investments in the teaching area provision.

7.7.4 Line manager support

Ten of the 15 interviewees felt their line managers were not supportive of their use of learning technologies, e.g.

“They would say [they are supportive], I think not.” (Jim)

“They have no interest in the use of computers in classrooms, and will probably continue to have no interest until somebody forces the issue.” (Mark).

Five interviewees felt their managers were supportive, primarily in terms of arranging training sessions and inputting resources. With three of these five, management support was seen as responsible for an increase in resources and a consequent increase in the interviewee’s use of CAL. In two cases the interviewees recorded that management support had increased over the past two years:

“[We’ve had] much more money pumped in recently.” (Bruce)

“There’s been a lot of financial support and interest from the management since QUILT has got going.” (Andrew).

In a third case the interviewee recorded that:

“[There has] not really [been a change]. Line management has always pressed for

[improved resources but] money has just been released this year.” (Simeon)

Andrew was the only individual who mentioned the effect of the QUILT programme, and it was clear that his increased resourcing, increased CAL use and increased management support had all been stimulated by his college’s involvement in QUILT. It was not clear whether the programme had been responsible for the same in Bruce and Simeon’s cases.

In summary

- The frequency of CAL use had stayed the same for eight of the 15 respondents.
- The frequency of CAL use had increased for six of the 15 respondents, and this was often accompanied by an increased use of the Internet.
- Only four of the 15 had had any IT training since completing the survey.
- Only five of the 15 respondents had had an increase in their teaching area resourcing.
- Where teaching area resourcing had increased, this was seen as a stimulus for increased CAL use, and vice versa.
- Only five of the 15 felt they had management support for their use of learning technologies; in two cases this support had increased over the past two years.

In general, the follow-up questionnaire indicated that the initial effects of QUILT, and any associated changes in the biology teachers’ computer use and computer environment, were sporadic.

7.8 Conclusions

The factor which emerged from the First Interviews as having the greatest impact on the interviewees' use of CAL was whether they had colleagues who they felt were using computers well in their teaching. The few who clearly stated that they had effective computer-using colleagues appeared to be working in open, co-operative departments, where the resourcing was comparatively good. The initial stimulus for this improved resourcing appeared to have come from one departmental member, although the development of a collaborative momentum was evident in some of the accounts. Figure 7.1 illustrated this interaction and is reproduced here.

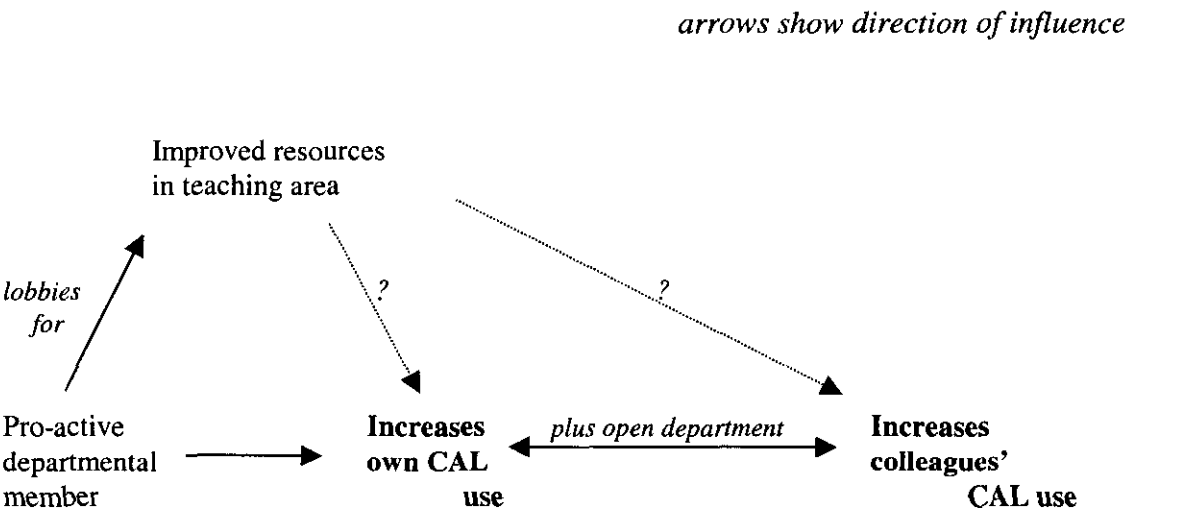


Figure 7.1 Grappling with the obstacle course: the relationship between resourcing and the influence of colleagues

The initial findings about the impact of resourcing on the interviewees' CAL use concentrated on hardware, and indicated that hardware resourcing had less of a direct effect than was suggested by the literature and the survey (see Chapters Two, Three and

Four). However, the findings from the follow-up questionnaire showed that improvements in resourcing were seen by some of the respondents as directly responsible for their increased CAL use, and vice versa. It was suggested in Section 7.7.1 that resourcing issues might best be investigated using longitudinal studies, but at this stage it is possible to say that improved resourcing (particularly of hardware) has a stronger influence on increasing CAL use than is shown in Figure 7.1; this is reflected in Figure 7.2 (see later).

Findings from both the pilot study and the First Interviews indicated that the interviewees' perceptions of the adequacy of their hardware resourcing were determined not by some arbitrary base-line, but by whether the hardware could run the software they wanted it to run and support the learning activities they wanted it to support. Therefore it seems that both the "perceived usefulness of software" factor and the classroom dynamics factor have an impact on the resourcing factor; this impact is explored further in Chapters Eight and Nine respectively.

The factor which emerged from the survey (see Chapter Four) as having the greatest impact on the teachers' CAL use was their previous exposure to the use of computers in HE. It was noted in Section 4.3.4 that this finding accorded with the findings of several of the studies discussed in the literature review (e.g. Downes, 1993; Becker, 1994; Kerr, 1991) which suggested that exposure to the practice of computer-using colleagues was important for teachers' development of classroom computer use. It was further noted that these studies had focused on "current exposure", but that the survey findings indicated that "historical exposure" (that is, when the teachers were still students) was also important. It was suggested that this was in line with Cuban's (1986) observation that an individual teacher's practice was based to a large extent on the practice they

observed when they themselves were students. In the light of the findings from the First Interviews it is suggested that both previous exposure to computers in education, and current exposure to other colleagues' use of computers, promote a familiarity with the classroom use of CAL. This in turn appears to both stimulate and be further stimulated by the individual's own classroom use of CAL. These findings are illustrated in Figure 7.2 (overleaf), which is a modified version of Figure 7.1.

Chapter Eight explores how teachers' CAL use is affected by access to software which they perceive as being useful. However it was clear from the First Interviews that many of the interviewees perceived the *lack* of good software as highly constraining their current use of CAL. The interviewees stressed that available software was generally not targeted at their teaching area, and that it was often lacking in interactivity and failed to exploit the computer's potential to do something which could not be done with traditional resources.

There was some connection between the interviewees' views of software and their conceptions of teaching and learning, as gauged using the Prosser et al (1994) classification scheme; this is explored further in Chapter Eight. However, there did not appear to be a direct connection between the individual's degree of student- or teacher-centredness and their level of CAL use. This observation is at odds with some of the literature (e.g. Hodas, 1993; Loveless, 1996), but the discrepancy may reflect the fact that this literature was about a different part of the educational sector.

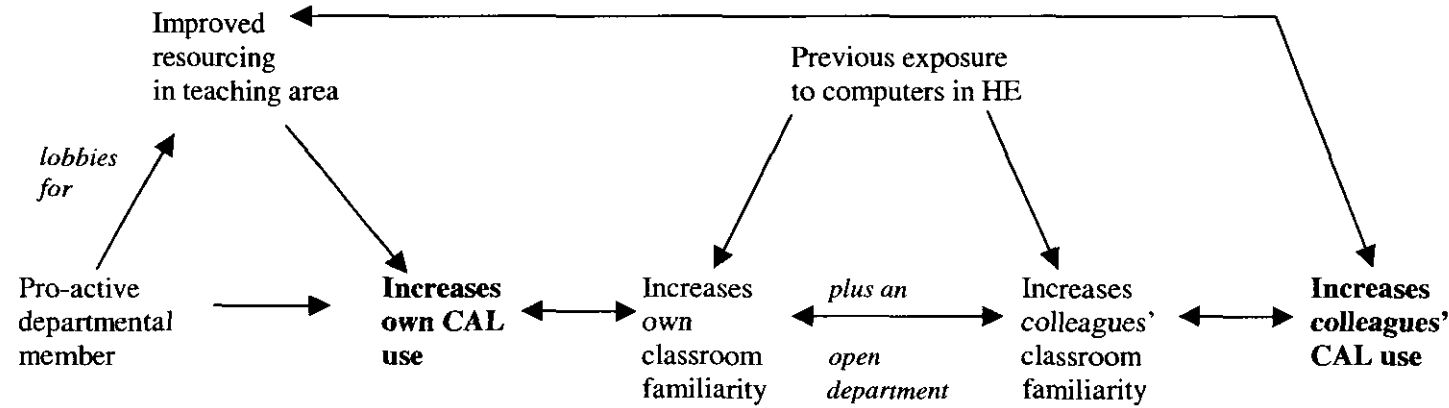


Figure 7.2 Grappling with the obstacle course: the relationship between resourcing, influence of colleagues and previous exposure to computer use in education

One of the aims of this thesis was to suggest how teachers could be helped to increase their use of CAL. The findings from First Interviews suggested that such help needs to be targeted at improving classroom resourcing and helping teachers to develop classroom familiarity with educational technology. It appeared that the latter could be encouraged by fostering openness and collaboration amongst departmental members so that they become aware of how others are using software with their students. For example, FE staff development programs, many of which still focus on the acquisition of *general* computer skills, might be improved by the incorporation of formally timetabled double-staffing for classes where CAL is being used.

However, Watson's (1993a) warning that staff development initiatives need to "depersonalise the innovation from the user" (p. 274) should be borne in mind and may provide an explanation for the lack of IT diffusion seen in two of the cases examined in Section 7.4. In these two cases the individuals concerned, James and Peter, used computers regularly in their teaching and appeared to work in open and communicative departments. However, their CAL use had not spread to their colleagues. It was noted that these two were experienced general computer-users, and it was suggested that their colleagues could have been discouraged in using CAL in their own classes because they associated such use with James and Peter's experienced general use, and felt this was something they could not emulate. It is suggested here that any double-staffing initiatives would need to place staff together carefully so that less experienced individuals (the 'learners') would be working with slightly more experienced individuals (the 'tutors').² In this way the innovation would not so much need to be

² Although it is also recognised that this could be a considerable undertaking.

“depersonalised” from the tutor. Instead it could be “repersonalised” by the learner, because the learner and tutor would not be too dissimilar for such a cross-over to occur. Bruner’s (1986) describes this type of assisted learning as “scaffolding” and suggests it provides the most effective means of skills development for children and novice adults alike.

Finally, full consideration of the theories on the diffusion of innovations is beyond the scope of this thesis. However, it is interesting to note that several key theories stress the importance of communication, Change Agents and context in the spread of an innovation through a community; these three elements were also stressed in the findings from the First Interviews. For example, Hagerstrand (1967) (cited in Fung, 1997) describes the different patterns of communication between adopters and potential adopters as crucial in the spread of an innovation; the thesis findings similarly stressed the importance of open and communicative departments in allowing the spread of an innovation from the pro-active individual to his or her colleagues (see Figure 7.2). The importance of Change Agents is described by Rogers (1983) (cited in Fung, 1997), i.e. individuals or events which encourage the spread of the innovation through a community. Following analysis of the First Interviews, the Change Agents in these FE biologists’ working environments were easily identified as the pro-active individuals (see Figure 7.2). Finally, Brown (1981) (cited in Fung, 1997) emphasises the importance of the context in which the innovation takes place. The thesis findings have so far stressed the importance of context in terms of resourcing, and, the next two chapters address issues of context in more depth.

Chapter Eight: Main Study Second Interviews

It was noted in Section 7.8 that the First Interviews had yielded some information about the interviewees' perceptions of the usefulness of software, but that this area needed further exploration; the main aim of the Second Interviews was to provide this exploration. The secondary aim was to see how the interviewees thought they might use software in their teaching. This chapter describes the Second Interviews under the following headings:

Section 8.1 *Some practical aspects.* This section briefly describes additional practical aspects to setting up, carrying out and analysing the Second Interviews.

Section 8.2 *Level 1, 2, 3 rating of the interviewee/software interactions.* This section describes the first step in the analysis. This involved classifying each interaction between teacher and program into one of three levels, 1, 2 or 3. The rating is used extensively throughout the chapter.

Section 8.3 *Positive and negative features of the software.* The reasons underlying the interviewees' decisions about whether to use the software programs are explored in this section; this involves an examination of the level 3, level 2, and level 1 interactions in turn. The interviewees are viewed in this section as a relatively homogeneous group.

Section 8.4 *Using the programs in the classroom.* This section describes the different ways in which the interviewees said they would use the software in their classrooms.

Section 8.5 *A summary of the individual programs.* Here the analysis given in Section 8.3 is summarised for each individual piece of software.

Section 8.6 *The individual teachers*. This section examines the key differences in the individual interviewees' responses to the programs, referring also to information derived from the survey and First Interviews.

Section 8.7 *Conclusions*. This section summarises the conclusions drawn from the Second Interviews about the nature of the interviewees' perceptions of the usefulness of specific pieces of software.

8.1 Some practical aspects

The format of the Second Interviews was described in Section 5.5.2, practical considerations in Section 5.6, and the broad analytical approach in Section 5.7. This section describes some of the additional aspects to setting up, carrying out and analysing the Second Interviews.

Following the survey, all respondents who had indicated a willingness to be involved in further studies were sent a letter (see Appendix Six) which outlined the procedure for the interviews and gave details of the software pool. The potential interviewees were then contacted by telephone in order to discuss the interview procedure and set interview dates. During this conversation they were asked which three pieces of software they would like to look at. If they asked for recommendations based on their areas of interest, then these were given.

The interviews were variable in length, ranging from approximately 45 to 120 minutes. Each interviewee looked through at least three pieces of software, and so, in general, most programs were reviewed for at least 15 minutes. Because most of the programs were taken along to each interview, several interviewees looked at additional programs once they had finished reviewing the three they had chosen. In this case only the first three reviews were analysed, in order to allow comparisons to be made with the

rest of the group. There were three cases where the interviewee looked through two pieces of software from the general pool and a third which was from outside. In two cases this was because there were difficulties in trying to install the general pool programs. In the third case the additional piece of software belonged to the interviewee and was used because she felt the other titles were inappropriate for her specialised area of teaching (fish science).

Initial notes were made immediately following each interview. The interviews were tape-recorded and transcribed. The first 10 interviews to be analysed were fully transcribed; the final 10 were partially transcribed following the pilot study analysis. The transcripts were analysed following the broad approach outlined in Section 5.7. Extensive use was made of coding and matrices, with the researcher moving backwards and forwards between extracted data and original transcripts in order to retain the integrity of the original text. In parts of the analysis two individuals analysed the same material (see Section 8.3.1). Methodological details are given throughout the chapter where it is thought that such details are useful to the reader.

The only instructions given to the interviewees were that they were asked to talk about

- a) their initial impressions of a program
- b) whether they would use it in their teaching
- c) if so, how and why would they use it
- d) if not, why not.

These instructions were therefore very focused on the practical consequences of the teachers' evaluation of the software, and this focus was reflected in the texts. As a result, almost all the interactions between an individual teacher and an individual piece of software could be rated by the researcher, according to whether the teachers said they

would use the software inside the classroom, outside the classroom, or not at all. This rating constituted the first major step in the analysis, and is described in the next section.

8.2 Level 1, 2, 3 ratings of the interviewee/software interactions

During the analysis the three pieces of software each individual looked at were rated level 1, 2 or 3 as follows:

- | | |
|--|---|
| Interviewee would use the software in the classroom | 1 |
| Interviewee would encourage students to use the software outside the classroom | 2 |
| Interviewee would not use the software at all | 3 |

In the majority of cases it was clear which rating the software should have, even though the level of enthusiasm for the programs varied within each category. The following section uses examples from each category to illustrate this, and briefly discusses problematic ratings.

8.2.1 Rating examples

Level 1 programs were those which the interviewees said they would use in the classroom. For the most part they were talked about with enthusiasm, e.g.

“Oh that's beautiful, it would be ideal for use in the classroom ... It just does the job so well and much more effectively than perhaps a video could do, because you've just got the flexibility.” (Linda on How Animals Move)

Some were referred to less enthusiastically, but still with the suggestion that they would be used in the classroom, e.g.

Would you use this in the classroom?

“Yeah. I'm not sure how until I have a good sort through it. I just see it as an extra way to provide a bit of variety, to get them interested in the subject.” (Bill on Biodiversity).

Level 2 programs were those which the interviewees said they considered suitable for use outside the classroom. For the most part their assessment of these programs was less enthusiastic than the assessment of level 1 programs, e.g.

“The visual look of the whole thing is not very 90s, and I'm afraid that will be seriously held against it by the students ... there's a lot of potential in those simulations, but ... I'm not that impressed.” *Could you see yourself using it in the classroom?* “Not in the classroom, because that's pushing the topic a little bit further than we've got time for.” (Mark on *Biological Simulations*).

Level 3 programs were those which the interviewees said they would not use at all. For the most part there was a considerable degree of criticism voiced about these programs, e.g.

“I would expect a little more sophistication and ideally something where it goes on to the next screen where you can see it graphically presented and then you can go back to this screen.” ... *Not appealing?* “No, because to be honest it doesn't do anything which is any more useful than you can do on a piece of paper ... The students enjoy playing with maggots and seeing if they've drowned - it's much more fun to do it in practical!” (Linda on *Biological Simulations*).

In three cases the rating was not possible. In two cases this was because it was not clear whether the rating should be level 1 or level 2. In the third case it was because, even though the individual expressed some degree of enthusiasm for the program, ultimately he did not say whether he would use it in the classroom or not, despite direct questioning, as follows:

“Now if you could .. make it look a bit more sophisticated so that it displays better, and the mechanics of doing it was easier, then I think that would be really useful.” ... *So you might use this?* “As I say I've been hoping that they would develop these kind of applications in a better format.” (Peter on *Biological Simulations*).

These three problematic ratings have been, where stated, excluded from much of the following analysis.

8.2.2 Results of the level 1, 2 and 3 ratings

Table 8.1 shows the overall ratings. In this table the programs are arranged in order so that the most commonly reviewed programs appear first.

Table 8.1 Ratings from the software/interviewee interactions

Software	No. of reviews	Rating
<i>How Animals Move</i> (CD-ROM)	12	7 at level 1 2 at level 2 1 at level 3 2 uncertain
<i>Biodiversity</i> (CD-ROM)	7	3 at level 1 4 at level 3
<i>The Ultimate Human Body</i> (CD-ROM)	7	2 at level 1 4 at level 2 1 at level 3
<i>Images of Biology</i> (CD-ROM)	7	5 at level 1 1 at level 2 1 at level 3
<i>Mitosis and Meiosis</i> (tutorial)	6	4 at level 1 1 at level 2 1 at level 3
<i>Recombinant DNA</i> (tutorial)	6	2 at level 1 2 at level 2 2 at level 3
<i>Biological Simulations</i> (simulation)	5	1 at level 2 3 at level 3 1 uncertain
<i>Swift-test</i> (tutorial)	3	1 at level 1 2 at level 2
<i>SimEarth</i> (simulation)	3	3 at level 2
<i>Darwin's Voyage</i> (tutorial)	1	1 at level 2
<i>GenScope</i> (tutorial)	1	1 at level 2
<i>Body Insight</i> (tutorial)	1	1 at level 3
<i>Australian Fishes for Aquariums</i> (tutorial)	1	1 at level 2

Three main points emerge from Table 8.1, as follows.

1. The number of ratings at each level was as follows:

Level	Number of ratings
1	24
2	19
3	14
Unclassified	3
<i>Total</i>	<i>60</i>

In many of the interactions the teachers viewed the programs as being usable in some way (that is, the ratings were at level 1 or 2). This indicated that the approach used in choosing the original pool of programs was appropriate for the research. However, in over half the interactions the programs were seen either as unsuitable for use inside the classroom (level 2), or as unsuitable for any use (level 3). This meant that there were a considerable number of interactions which could be used to investigate problem areas.

2. Despite the fact that the interviewees mostly taught on a similar range of courses, their evaluations of the individual programs were very variable. Most of the programs which were viewed by more than three interviewees received all three ratings; for example, *The Ultimate Human Body* received two level 1s, four level 2s, and one level 3. This variability is explored further in Section 8.6.

3. The interviewees selected which programs to look at based on the descriptions sent to them before the interviews (see Appendix Six), therefore the number of times each program was viewed can be taken as an indication of its initial appeal on paper. However, as noted earlier, *GenScope*, *Body Insight* and *Australian Fishes for Aquariums* were not in the original pool, and were only available for one teacher each to look at.

The programs which the interviewees particularly wanted to look at appeared to be those which were seen as:

- applicable for the syllabuses (e.g. *Images of Biology*, which is linked to a well regarded A-level text book, *Recombinant DNA and Mitosis and Meiosis*)
- interesting in terms of multimedia (e.g. *How Animals Move* and *The Ultimate Human Body*)
- having been produced by individuals or organisations who were academically well regarded (e.g. *Biodiversity* and *Images of Biology*).

The most popular viewing choices were the four CD-ROMs, and this reflected the interest shown in CD-ROMs in the survey responses (see Section 4.3.6).

By contrast, those programs which were rarely or never viewed appeared to be seen as:

- not directly applicable to the syllabus (e.g. *MacFrog* and *Darwin's Voyage*)
- uninteresting in terms of the title or overall description (e.g. *Plant Stacks*)
- not posing a significant benefit over what the interviewees already used (e.g. most interviewees used Excel and several noted that they were therefore not particularly interested in looking at *StatView 4*, which, they suggested, would go beyond their teaching needs).

The themes of syllabus match, multimedia appeal and academic respectability appear throughout the analysis, and are addressed in the next section.

8.3 Positive and negative features of the software

The aim of this section is to explore the software features which influenced the interviewees' decisions about whether to use individual programs in their teaching.

Consequently the interviewees, despite their different attitudes towards the software, are viewed as a relatively homogeneous group. However, during the analysis care was taken not to "pool" the interviewees in a way which allowed individual differences to be obscured. Therefore their identities are retained throughout this section, even though the exploration of individual differences does not occur until Section 8.6.

There are four parts to this section: Section 8.3.1 outlines the reasoning behind the analytic categories (or codings) used, and Sections 8.3.2 to 8.3.4 address the level 3, level 2, and level 1 interactions in turn. The interactions are examined in this sequence because some of the reasons underlying why an interviewee *would* use the software (level 1) are not mentioned directly, and only emerge by comparison with the reasons given for why they *would not* use software (levels 2 and 3).

8.3.1 Analytic Categories

The categorisations for Section 8.3 changed significantly over a period of time. The texts for each interviewee/program interaction were pooled according to whether they were rated level 1, 2 or 3. These pools were then coded in order to establish general groupings of positive and negative comments. Initially it seemed as though the comments fell under three broad groupings, as follows:

1. negative comments about the software providing no benefit over traditional resources
2. negative comments about the software being problematic in practical terms (e.g. failing to meet syllabus or resourcing constraints)
3. positive or negative comments about pedagogical issues (e.g. the organisational clarity of the information and the quality of the interaction with the user).

These groupings were consistent with the categories which surfaced both from the pilot study (see Section 6.4) and from the analysis of comments made about currently

available software during the First Interviews (see Section 7.5.1). The comments classified under these three groupings also appeared to show a clear pattern across the three levels of rating, as follows:

Reason for concern	No. of cases of concern expressed for level 3 programs (out of 14)	No. of cases of concern expressed for level 2 programs (out of 19)	No. of cases of concern expressed for level 1 programs (out of 24)
No benefit over traditional resources	10	4	2
Pedagogical concerns	9	7	6
Practical concerns	6	16	3

However it became apparent that there was a qualitative difference between the first category and the other two. Comments included under the category, no benefit over traditional resources, essentially involved the teacher expressing the opinion that there was "no reason to use" the program. By contrast, the other two categories, practical concerns and pedagogical concerns, essentially involved the teacher expressing the opinion that there was "a reason not to use" the program. A closer examination of the texts revealed that whereas practical problems or pedagogical problems often represented a teacher's *primary* objection to a program, the fact that it might be no benefit over traditional resources, although it was often mentioned, rarely seemed to be a deciding factor in their decision about whether to use it. However, there were cases where the primary objection was that the software was actually *disadvantageous* by comparison with traditional resources in that there were better alternatives.

As a result of these anomalies the texts were re-coded in order to find the *primary* reasons behind a teacher's decision about whether or not to use the program. There were concerns about the degree of subjectivity involved in this process, so other researchers were brought in for check-coding. The re-coding therefore involved a number of steps, as follows:

1. the main researcher re-coded the texts and established a list of primary reasons for use or non-use of the programs
2. two other researchers re-coded the texts using the list established by the main researcher
3. all three compared their ratings in order to arrive at a consensus.

As expected, in certain cases it was difficult to identify just one primary reason for the interviewee's choice about whether or not to use a program. However, there was a high degree of agreement between the three researchers on the main reasons underlying the interviewees' decisions, and, following discussion, they were able to reach agreement in all cases.

Following re-coding, the range of primary reasons behind a teacher's decision *not* to use a program fell, mostly, into three groups, as follows:

1. comments about **information**, for example, whether or not the information in the program matched the syllabus requirements and a teacher's requirements for quality
2. comments about **interaction**, for example, whether or not the program was sufficiently interactive or entertaining
3. comments about **practical issues**, for example, whether or not the program matched the computing resources available, or the time available for its use.

There were only two cases where the interviewees' objections to a program did not fall under one of these categories; they both involved programs for which the interviewees felt there were **better alternatives**.

To a limited extent these categories also represented the primary reasons behind a teacher's decision *to* use a program. However, it became clear that the reasons for use did not just represent a straightforward inversion of the reasons for non-use, and attempts to place them in identical categories were in danger of obscuring the real picture; this is discussed further in Section 8.3.4.

The next three sections examine the level 3, level 2 and level 1 interactions in turn.

8.3.2 *Level 3*

Programs that were classified at level 3 were those which the interviewees said they would not use at all. There were eight such programs and 11 such interviewees. Table 8.2 shows them, and maps out the areas of concern.

Table 8.2 Concerns expressed during level 3 interactions

Program	Used by	Nature of concern			
		Information	Interaction	Practical	Better alternatives
<i>How Animals Move</i>	Mark			*	
<i>Biodiversity</i>	Peter	*	*		
	Pam		*		
	Gary	*			
	Jean	*		*	
<i>Ultimate Human Body</i>	Gary	*			
<i>Images of Biology</i>	Bruce	*			*
<i>Mitosis and Meiosis</i>	Bruce	*	*		
<i>Recombinant DNA</i>	Mark			*	
	Simeon		*		
<i>Biological Simulations</i>	Beth	*			
	Linda		*		*
	Judy		*		
<i>Body Insight</i>	Graham	*	*		

Table 8.2 shows that, for the most part, when the interviewees decided they would not use the program at all this was because of concerns about its information and/or the quality of its interaction with the user. Practical concerns and concerns about the fact that there were better alternatives were much less common. The following four sections briefly address each of these four areas of concern.

Information concerns

The software had been carefully selected in order to match the syllabus requirements of the courses most of the interviewees were teaching on. However, in three of the eight

cases where concern was expressed about the program's information, these were because of syllabus mismatch, e.g.

“We have colleagues who are dealing with animals and plants, but it's not really “human” enough for me.” (Gary on *Biodiversity*)

“[I would never be teaching this, in] human biology, you don't even do this at A-level.” (Graham on *Body Insight*).

It was easy to track down the reasons for the mismatch in these three cases. In Graham's case the program he was reviewing was not a part of the software pool and was only being used because of problems with the other software. In Gary's case, his teaching specialism (BSc and MSc pharmacology) fell outside the target area for the software pool. Gary's assessments of the software demonstrated the benefit of including “outliers” (see Section 5.7.3) in the research; his were the only interactions where it became clear that even when the interviewee admired the quality of the software, they were very unlikely to use it if it did not match their syllabus requirements, e.g.

“Well I think for the level it's pitched at it's pretty good, [but] it's not particularly applied to the area I teach [and] I would find it hard to justify its use in this particular form, but having said that, its production and the presentation is good.” (Gary on *The Ultimate Human Body*).

A similar situation was evident in Jean's interview. Jean's teaching specialism was fish science, and so she was also unusual in terms of the interviewee group. Jean chose to review two programs (*How Animals Move* and *Biodiversity*) which appeared from their titles and descriptions to have relevance to her teaching. However, she could not find a third program which she thought worth spending time reviewing, and so chose instead to show the researcher a program she had found (*Australian Fishes for Aquariums*) on which she was particularly keen.

The other comments which fell under the information category were to do with the quality of information contained in the programs. These comments demonstrated concerns about:

a) inconsistency:

Is it a bit too technical?

“Well once you get into it it's not, it's only got three sentences on a gastropod for example ... But as a classification chart this gives all the Latin names [and] most students would actually run away from that. And it goes from that to being quite simple.” (Jean on *Biodiversity*)

“Unusual knowledge levels ... you've got every muscle ... but it doesn't do ultrastructure ... and I don't know why it doesn't.” (Graham on *Body Insight*)

b) misleading information, or a surface approach:

“I thought ... the examples would be better and there would be more depth to it.”
(Peter on *Biodiversity*)

“I was hoping it would show loss or fixation with different population sizes ... Hmm, I don't think I'm convinced by this particular package! I think teaching biology with software is fine as long as there's good software - this is very weird!” (Beth on *Biological Simulations*)

c) concentration on detail at the expense of the overview or the biological significance:

“It should also be stressing the biological significance more, all it's doing is giving a load of facts, not the overview. It should be emphasising why this ... is happening ... That's far more important than the actual mechanics of what's going on.” (Bruce on *Mitosis and Meiosis*).

As noted in the pilot study (Section 6.4) Bruce's objections to the software showed a close link with his conceptions of teaching and learning. This was also evident in the assessments of a number of other interviewees and is addressed in more detail in Section 8.6.

Interaction concerns

Interaction concerns occasionally focused on navigational problems, e.g.

“I don't know where I am.” (Mark on *Recombinant DNA*)

“Why don't they put the ** name on the icon?” (Graham on *Body Insight*).

However, although these concerns were clearly irritating, they never emerged as primary reasons for a program's rejection. The primary reasons instead reflected the concerns expressed about currently available software during the First Interviews (see Section 7.5.1). They centred mostly on the lack of interactivity and the consequent failure to engage the users, e.g.

“The way it's presented is not very inspiring - students get quickly bored with having to click through pages and pages” (Peter on *Biodiversity*)

“You have a *little* bit of control, and maybe that makes it slightly more interesting for students. My experience of that is that it doesn't, they're very cynical about that and they get very bored very quickly.” (Judy on *Biological Simulations*).

Practical concerns

In one case the interviewee focused on the lack of engagement from a different perspective, that of a teacher who needed student engagement for classroom management, rather than in order to increase the students' learning capacity, e.g.

“It's not exactly SimCity or Doom, and therefore is not going to hold their attention for too long.” (Jean on *Biodiversity*).

This classroom management perspective represented one of the few practical concerns expressed during the level 3 interactions. The other concerns were both voiced by Mark, who found two of the programs problematic in terms of how they could be integrated into the curriculum, e.g.

“[Is this] trying to be a self-contained package – which would be fair enough – [but] if you just put *everything* in there ... then it cannot be a self-contained package, what

you're saying is that someone else has to provide the other [pruning] bits of information that need to go in." (Mark on *How Animals Move*)

"It would be lovely to have a system where we could say - we're going to spend a little bit more time doing practical work because we can trust you to go to the library and learn this topic. So how does this package fit into that? ... I don't think it would hit - I don't think students would know what they need to know." (Mark on *Recombinant DNA*).

Practical concerns were expressed far more commonly in level 2 interactions.

Concerns about programs having better alternatives

There were only two comments falling under this category. In both cases they concerned the fact that the program was designed to replace time consuming and/or difficult experiments. In one case the interviewee noted that the experiment was far more engaging than the program which was designed to replace it, e.g.

"To be honest it doesn't do anything which is any more useful than you can do on a piece of paper ... it's much more fun to do it in a practical!" (Linda on *Biological Simulations*).

In the other case the interviewee stressed that the usual practical activity was more effective than the software and allowed the students to develop valuable skills, e.g.

"This is just showing slides which you could see far more effectively down microscopes, and you could get the students practising using the microscope" (Bruce on *Images of Biology*).

In summary

From this examination of level 3 interactions it seemed that the main grounds for rejecting a program were if:

- it did not fit the syllabus (this went against a program even when all the other aspects were favourable)

- the information quality was not good (for example, if it was misleading or inconsistent or did not fit with the teachers' pedagogical approach)
- the quality of the interaction between the user and program was not good (particularly when it was not interactive enough and therefore boring)
- (to a lesser degree) it was felt that there were better alternatives
- (also to a lesser degree) it appeared to be difficult to integrate into the curriculum, that is, the way the syllabus was delivered.

8.3.3 *Level 2*

Programs that were classified at level 2 were those which the interviewees said they would only use outside the classroom. There were 11 such programs and 15 such interviewees; they are shown in Table 8.3. Use outside the classroom represented a broad category. In some cases this intended use appeared to be tightly integrated into the curriculum the teacher delivered (e.g. with prescribed homework or assignments, or group activities in learning centres) and in other cases it appeared to consist of a more general recommendation that the students might find the program useful as another resource.

This section has two sub-sections. The first examines the primary reasons why the interviewees *would not* use these programs in the classroom, and the second examines the primary reasons why they *would* use them outside the classroom.

a) Why the programs would not be used in the classroom

The sense that there were better alternatives to a program did not appear in the level 2 comments, but the other three categories, information, interaction and practical concerns, all did. However, within these three categories the overall distribution was very different to the distribution evident in the level 3 interactions, as Table 8.3 shows.

Table 8.3 Concerns expressed during level 2 interactions

Software	Used by	Area of concern		
		Information	Interaction	Practical
<i>How Animals Move</i>	Phil Stephen	*	*	
<i>The Ultimate Human Body</i>	Jim Pam Maria Angela	* * *	*	
<i>Images of Biology</i>	Judy			*
<i>Mitosis and Meiosis</i>	Liz [♦]			
<i>Recombinant DNA</i>	Bruce Liz			* *
<i>Biological Simulations</i>	Mark		*	*
<i>Swift-test</i>	Maria Bill		*	*
<i>SimEarth</i>	Jim Peter		* *	* *
	Graham		*	*
<i>Darwin's Voyage</i>	James			*
<i>GenScope</i>	Judy		*	*
<i>Australian Fishes for Aquariums</i>	Jean			*

[♦] = Liz's precise area of concern was not clear.

Information concerns

Information concerns were primary in only four cases. These were all to do with a degree of syllabus mismatch which was far less marked than the mismatch shown in the level 3 interactions, e.g.

“It’s quite nice, it’s a bit basic ... It would probably be something I’d use in the library.”

(Angela on *The Ultimate Human Body*).

There were no complaints here about the quality of the information in terms of its consistency, accuracy or pedagogical perspective, and this represented a major difference between level 2 and level 3 interactions.

Interaction concerns

Although there were still a number of concerns about the quality of the interaction between the user and the software, there was another major difference between level 2 and level 3 interactions in the *type* of concern expressed here, with only three interviewees complaining about lack of engagement, e.g.

“I just don’t think it’s stimulating - I don’t think it does anything that you can’t do yourself.” (Pam on *The Ultimate Human Body*)

“It’s a bit boring .. I suppose if I was learning it I would find it useful.” (Bill on *Swift-test*).

The other four interaction concerns seemed to show that when lack of engagement was no longer an obvious barrier, the interviewees started to focus on issues beyond this. These were generally to do with whether the software would deliver quality learning, e.g.

“I think an awful lot of students would use this and look as though they’re doing something, but actually it would transpire that they’re just playing with things.” (Phil on *How Animals Move*)

“I think [the students] would have a nightmare trying to get started ... I don’t really know what’s going on here.” (Graham on *SimEarth*).

Practical concerns

Comments about the user/software interaction overlapped to some degree with comments that related to practical concerns. Practical concerns accounted for 11 of the

major objections expressed in the level 2 interactions, by comparison with only three major objections in the level 3 interactions. Again it seemed as though once the more obvious barriers to use were removed (i.e. syllabus mismatch, poor information and lack of engagement) most of the teachers started to focus on issues to do with how the program could be used effectively in their classrooms, and therefore started to articulate practical concerns.

Classroom activities take place in a prescribed area and within a prescribed time, it was therefore unsurprising that issues such as resourcing and timing featured under the practical concerns. It was rather more surprising that resourcing concerns, which emerged so strongly through the survey, were only expressed as primary concerns in two cases. It seems likely that this was because the focus in the Second Interviews was on specific programs, and resourcing concerns related more to the use of CAL in general. For example, in the following quotes, Bruce and Judy both highlighted general resourcing concerns rather than concerns specific to the programs they were looking at:

“To get the students around one computer, for example, would be a joke and a half.”
(Bruce on *Recombinant DNA*)

“I think the problem in the classroom is always one of access to machines.” (Judy on *Images of Biology*).

A closer examination of the way the interviewees talked about resourcing revealed that, for the most part, they were not bearing in mind their *actual* resourcing levels, but instead seemed to be bearing in mind *realistically achievable* resourcing levels. For example, Bruce (see previous quote) did not have *any* machines in the classroom which would run the program he was looking at, but talked as though he had just one. This perspective was evident across all three levels, and is best illustrated by a quote on a level 1 interaction from Maria:

“It's quite hard, isn't it? Again it's the whole idea of one CD-ROM machine, **which is all you could ever hope to achieve in a classroom**, and a minimum of 12 students, often, you know, 17, 20 students and how would you use one machine?” (Maria on *How Animals Move*) (my emphasis).

This apparent suspension of concerns about their *actual* resourcing level also occurred during the teachers' observations (see Section 9.4.3).

The other nine practical concerns seemed to demonstrate the interviewees' need to balance the programs' benefits against the difficulties of incorporating them into the rigorous environment of the classroom. In five of these cases the interviewees came up against time issues. In some cases these reflected the fact that the program was simply not beneficial enough to allocate valuable class time to it, e.g.

“I'm enjoying sort of fossicking about, but, you know, there's always finite time.”
(James on *Darwin's Voyage*).

In other cases they reflected the fact that the program was simply too complex for straightforward integration, e.g.

“I'm concentrating so hard on what I'm doing here that nothing [about evolution] has struck me ... And maybe after you'd used it a few times [the students] might start to use it. But would you have time in a syllabus for them to actually use that? ... I like the idea of it, but just the practical way of working it, I'm not sure.” (Graham on *SimEarth*).

In four of these cases the practical concerns were all to do with the teacher's classroom dynamics and how the program would clash with these, e.g.

“You'd either get people wanting to play on the machine, or you'd get some people hogging the machine. Or you'd get some people wanting to play on it, but you'd want them to do some basic things first. So it would raise all those kinds of classroom management issues, you know.” (Judy on *GenScope*)

“Hmm I don't know how, I can't particularly see how I'd use it in the classroom. It's difficult, I could demonstrate it, that we had one, but I don't know how to particularly integrate it in. It's like saying, if I brought in a new book how would I use it in class - I can't just stand there and say it's got nice pictures in, so I would probably not be able to use it as such.” (Jean on *Australian Fishes for Aquariums*).

b) Why the program would be used

The reasons the interviewees gave for *using* the programs did not fall so neatly into the three categories that were used to frame the reasons they gave for *not using* the programs. There was some degree of overlap and many of the positive comments clearly addressed issues to do with information and interaction, but overall the focus shifted, so that the positive comments were not simply an inversion of the negative comments. This aspect is addressed again in Section 8.3.4.

When the interviewee decided that they would use a particular program *outside* the classroom, the most common reason given for its use was that it would provide a useful reinforcement for material which had already been covered, e.g.

“I’m sure that it would be good as a sort of reinforcement, revision aid, to go back over stuff.” (Liz on *Mitosis and Meiosis*).

This was given as the primary reason for using a program in six cases (see Table 8.4), and in these six cases the interviewees were, for the most part, fairly unenthusiastic about the program, e.g.

“Well, I wouldn’t criticise it too much, but I wouldn’t rave about it either, it’s just okay, it’s just revision.” (Bill on *Swift-test*).

In general, when the interviewees said they would use the program for reinforcement, they did not highlight concerns about how the program could be integrated into the classroom (see Table 8.4). It seems likely, then, that they did not view the program as being valuable enough to even begin to articulate the trade-off between benefits and costs which would be involved in its classroom use.

At the opposite end of the spectrum, in four cases the interviewees stressed that they would use the program outside the classroom because such use could be intrinsically

very valuable for students. In three cases this was because the program could be used to encourage independent work, e.g.

“I think a lot of these things are more suited to private study than the classroom, which is fine, because a lot of people find it difficult to learn things on their own.” (Phil on *Swift-test*).

In the fourth case it was because the program could be used to encourage a type of collaborative work which would be difficult to implement in a classroom, e.g.

“I could imagine being with two or three students and a couple of members of staff and saying - we've got this new program, let's have a look at it - and that being part of a whole process of using - which I find very exciting. It just adds to the richness of what the students are doing.” (Judy on *GenScope*).

Table 8.4, overleaf, shows the uses of, and integration concerns about, the level 2 programs.

Table 8.4 Perceived uses of, and integration concerns about, level 2 programs

Software	Used by	Perceived uses		Integration concerns
		Reinforcement	Other	
<i>How Animals Move</i>	Phil Stephen	*	*	
<i>The Ultimate Human Body</i>	Jim Pam Maria Angela	* *	* *	
<i>Images of Biology</i>	Judy		*	*
<i>Mitosis and Meiosis</i>	Liz	*		*
<i>Recombinant DNA</i>	Bruce Liz	 *	*	
<i>Biological Simulations</i>	Mark		*	*
<i>Swift-test</i>	Maria Bill	 *	*	*
<i>SimEarth</i>	Jim Peter Graham		* * *	* * *
<i>Darwin's Voyage</i>	James		*	*
<i>GenScope</i>	Judy		*	*
<i>Australian Fishes for Aquariums</i>	Jean		*	*

The “other” uses for the software fell under three main areas, information provision, conceptual/skills development and student engagement. These three types of use also feature in Section 8.3.4, which addresses level 1 programs. Information provision appeared to be the primary reason for use in four cases, e.g.

“It’s actually something my students could look through and read and it would be totally relevant to them.” (Jean on *Australian Fishes for Aquariums*).

Conceptual and/or skills development was key in another four cases, e.g.

“It’s very easy to miss out on the way in which things relate to one another [and the students] find it hard to put the microscopy image into something that is three-dimensional ... [But] they could use [this program] to move back and forth and build a picture.” (Judy on *Images of Biology*).

Student engagement was highlighted in two cases, e.g.

“It’s exactly the sort of thing that would keep their interest ... A friendly way of introducing the topic ... nice colour pictures, nice sound.” (Jim on *The Ultimate Human Body*).

In most of the cases where the program was seen as valuable for something other than reinforcement, the interviewees also articulated integration difficulties (see Table 8.4). So it seemed that, for the most part, the teachers considered using the program inside the classroom, and considered the issues associated with such use, only when they were satisfied that the program had a value beyond simple reinforcement. With most of the programs discussed in this section, the teachers appeared to weigh up the benefits against costs of using the program in the classroom, and decided against such use.

In summary

The analysis of the level 2 interactions added weight to the conclusions reached from the analysis of the level 3 interactions in showing that the interviewees only considered using software if there were no obvious concerns about:

- the program being appropriate for their syllabuses
- the quality of the information (i.e. in terms of its consistency, accuracy or fit with their pedagogic approach)

- the program's ability to engage the user.

Once these concerns were satisfied, then the interviewees started to consider whether the program had a specific value beyond reinforcement. If it did not, they consigned it to use outside the classroom. If it did, they then considered:

- whether it was specifically valuable for use outside the classroom, or
- how far its value for use inside the classroom balanced out against any integration difficulties.

The main integration concerns were about time and classroom dynamics. These also surfaced in the survey (Section 4.3.6) and the First Interviews (Section 7.5.1), and they are explored in more depth in Chapter Nine, which deals with the classroom observations. However, it is worth stressing here that concerns about time were particularly evident where the interviewees were focusing on intensive syllabus-based courses, e.g.

“[CAL can be] inappropriate for teaching A-level, Access, GCSE syllabuses - I’ve got to do it fast, really, really fast.” (Pam).

This observation reinforces those made in Section 7.5.2 about how A-level (or similar) courses appeared to be constraining the imaginative use of CAL.

Where the level 2 programs were seen as beneficial, it was largely in terms of information provision, conceptual/skills development and student engagement. These benefits were also mentioned with respect to level 1 programs, which are addressed in the next section.

8.3.4 Level 1

Level 1 programs were those which the interviewees said they would use in their classrooms. There were seven such programs and 15 such interviewees; they are shown in Table 8.5.

There were very few negative comments made about the programs featured in this section. Where reservations were expressed they were primarily about the more fine grained aspects of the interaction between the user and the program. The interviewees were particularly concerned about ‘games-playing’, e.g.

“I’m still not sure that most of this isn’t play. And I’m sure that a lot of students would play. I mean I’m playing now, I don’t know what I’m looking at, I’m playing. But then again, I suppose the more you use them the less you play.” (Liz on *Images of Biology*)

“I can just see them sitting here and not actually reading this, just going on to the next page and saying - oh let’s go on and see what happens, do you find that? Yeah, and I find it to an extent with myself, when I know there’s going to be animations involved. Yeah, actually, that’s what I’m doing now!” (Beth on *Recombinant DNA*).

However, for the most part it was clear that where there were drawbacks to the program’s use the interviewees seemed able to suggest ways of using it which would alleviate these drawbacks. This point is taken up again in Section 8.6.

As noted in the previous section, the reasons the interviewees gave for using programs were not simply a straightforward inversion of the reasons given for not using programs. During the analysis it became clear that whereas it was relatively easy to categorise the primary reasons for the teachers’ *rejection* of a program, it was far more difficult to categorise the primary reasons for their *acceptance*. It seems likely that this was because of a combination of two reasons, as follows.

The first reason was that the interviewees were, as a group, generally enthusiastic about CAL and keen to find software they could use in their classrooms.

Therefore many of them seemed to consider using the individual packages as long as there were no specific objections to such use; and so the objections were clearly articulated, but the specific reasons for use were not.

The second reason, which overlaps to some degree with the first, was that teachers generally operate within a number of externally applied constraints, such as subject matter, syllabuses, time, resources, and basic principles of teacher-student and student-task interactions. During the Second Interviews if a piece of software did not fit with these relatively generic constraints, then the reasons for the mismatch could be classified fairly easily. However once the constraints were satisfied, the teachers were able to make decisions according to more personal agendas, and these variable personal agendas were reflected in their variable primary reasons for using individual packages.

The final categories used to classify the teachers' reasons for using the programs are shown in Table 8.5 and then discussed in turn.

Table 8.5 Reasons underlying the use of level 1 programs

Software	Used by	Reasons for use				
		Conceptual and/or skills development	Student engagement	Information provision	Other	Classroom dynamics
<i>How Animals Move</i>	Maria	*	*			
	Jim		*	*		
	Pam	*	*		*	
	Bill				*	*
	Linda	*		*		*
	Jean		*			*
	Simeon		*	*		*
<i>Biodiversity</i>	Bill					*
	Angela					*
	Stephen	*				*
<i>The Ultimate Human Body</i>	Andrew	*				*
	Stephen	*				
<i>Images of Biology</i>	Andrew					*
	Liz					*
	Linda					*
	Phil		*	*		
	Graham	*			*	
<i>Mitosis and Meiosis</i>	Andrew					*
	James					*
	Beth	*				
	Simeon	*			*	
<i>Recombinant DNA</i>	James			*		*
	Beth			*		
<i>Swift-test</i>	Phil				*	

The categories shown in the first three columns overlapped with the categories evident in the level 2 interactions (see previous section). There were, however, a considerable

number of comments which did not fit into these three categories; these were classified under “other” or “classroom dynamics”.

Conceptual/skills development

This accounted for nine primary reasons. Here for most part the interviewees stressed how specific illustrations could bring about conceptual development, e.g.

“That’s beautiful, it would be ideal for use in the classroom so you could go through it to back up the theory, because when you can see it moving like that it just clarifies so well.” (Linda on *How Animals Move*)

“Now [the animations] I think are good because it’s showing you something you can’t see and you can’t imagine what’s actually happening.” (Graham *Images of Biology*).

However, in two cases the interviewees mentioned the usefulness of the program’s structure in helping students to avoid the persistent problem of isolating blocks of information, e.g.

“It’s a way of cross linking to different things, isn’t it? - it’s good for making connections to different areas, which [students] find really hard.” (Andrew on *The Ultimate Human Body*)

and in one further case the interviewee stressed the value of the program in skills development, e.g.

“[The students need practice at] being handed a body of data presented in a variety of forms and having to understand what the data is telling them, and then use it in some way. So this could be good.” (Maria on *How Animals Move*).

Student engagement

This accounted for six primary reasons, with the interviewees being particularly enthusiastic about programs which had visual appeal, or combined visual and auditory appeal, e.g.

“Oh isn't [the mandarin fish] great, isn't he wonderful. Excellent. I like this program a bit more now .. it's that thing of entertaining [the students] again.” (Jean on *How Animals Move*)

“Oh look at that - cytoplasmic streaming. That's marvellous ... I do like the [visuals, they] hold peoples' interest.” (Jim on *How Animals Move*)

“It is good, isn't it, because it's something the students can do by themselves [and] it's very nice because all this stuff can be very dry, and [it helps to lift it] if you've actually got a nice bright picture and a voice and that sort of thing.” (Phil on *Images of Biology*).

Information provision

This accounted for six primary reasons, with the interviewees stressing both syllabus fit, and information quality, e.g.

“Now that does look very, very useful. [It] would actually fulfil some of the syllabus requirements that we were going to find difficult.” (Linda on *How Animals Move*)

“That's very straightforward, excellent [you can] go into quite considerable depth.” (James on *Recombinant DNA*).

Other

There were five comments which could not be classified under student engagement, conceptual/skills development, information provision or classroom dynamics. Two of the ‘other’ comments centred on the importance of software being able to do something traditional resources could not, e.g.

“You see, that's something which I haven't seen on telly and which an individual student might want to take long time to look at ... Yes, that's a use which isn't duplicated in another way.” (Pam on *How Animals Move*).

One focused on the benefits in terms of saving staff time, e.g.

“It's also very useful, because we've got a lot of the same subject together, which saves us a job, because otherwise you have to fish out back papers and do a lot of photocopying.” (Phil on *Swift-test*).

One focused on the benefits in terms of saving money and overcoming practical difficulties, e.g.

“Things like [the sections shown on the software are] often quite difficult to get good illustrations on slides [also] it's much cheaper, you know.” (Graham on *Images of Biology*)

and one was to do with the fact that the program could be used for reinforcement, e.g.

“I would use it as backup ... I don't see a way of integrating that into a lesson to replace things I do now.” (Simeon on *Mitosis and Meiosis*).

The fact that there was only one comment about reinforcement represented a major difference between level 2 and level 1 programs, and supported the suggestion made in the previous section that programs which were seen as useful only for reinforcement were unlikely to be used in the classroom.

Classroom dynamics

The final column in Table 8.6 shows that most of the comments made about positive aspects of level 1 programs were to do with the specific benefits derived from using these programs in the classroom. These comments fell under three broad areas, as follows.

The use of a program to increase classroom variety was stressed in eight cases.

These comments were accompanied by a sense that the program was of limited value in other respects, e.g.

“I just see it as an extra way to provide a bit of variety, to get them interested in the subject.” (Bill on *Biodiversity*)

“I guess it's just nice to have the variety ... It's this thing of entertaining them again.” (Jean on *How Animals Move*).

Although the teachers were talking here about using programs in order to interest or entertain the students, this category differs from the student engagement category

described earlier because the engagement was not seen as a direct feature of the program itself, but simply the result of a change in activity.

The use of a program to increase student independence was stressed in five cases. The development of student independence was cited as a reason for using specific software packages outside the classroom (i.e. with level 2 interactions, see Section 8.3.3). However, with the level 1 interactions such use was addressed more as a feature of classroom management than a means of developing independent learning skills, e.g.

“The GNVQ [students] have to get on with their own work and you're checking on them, and this would be excellent for somebody who is working through on their own.”
(Beth on *Recombinant DNA*).

There was often some degree of overlap between this and the student engagement category, e.g.

“Me doing drawings on the board and faffing around with OHPs and things like that can get to be a bit dull. This way [the students] work through it at their own pace.”
(James on *Mitosis and Meiosis*).

Finally, there was a general sense from six of the interviewees that the program was valuable because it fitted in with their classroom activities, e.g.

“Now this [I could fit in with] our cell divisions and locust testes squashes and what have you ... and it would form part of the sort of package ... I mean that's the perfect amount of knowledge, 'cause they could get through that in 10, 15 minutes quite easily.” (James on *Mitosis and Meiosis*)

“That's actually quite nice, because we get the students for A-level to do a biological drawing of mitosis, so something like that which shows the stages is quite good [and they could] annotate their own set of line drawings from what they can get on the CD-ROM.” (Linda on *Images of Biology*).

This sense of “classroom fit” is explored in more detail in Chapter Nine.

In summary

This account of level 1 interactions showed that, as with level 2 interactions, the teachers only considered using software when

- there were no concerns about syllabus mismatch
- there were no initial concerns about the quality of the information (i.e. in terms of its consistency, accuracy or fit with the teacher's pedagogical approach)
- there were no initial concerns about the program's ability to engage the user.

The analysis of level 2 interactions suggested that once these concerns were satisfied the teachers were able to move on to consider the program's actual value. If this value was only seen in terms of reinforcement or revision then the program was generally not considered for use inside the classroom; the fact that reinforcement was the primary reason for use in only one of the 24 level 1 interactions adds weight to this observation.

In the analysis of the level 2 interactions it seemed that if the teachers saw the program as having a value beyond reinforcement, they then began to articulate how far this value balanced against the perceived difficulties of using the program in the classroom. In the level 1 interactions articulations of integration difficulties were almost completely absent, suggesting that these were not seen to present a significant problem in the program's use. However, whereas the level 2 interactions revealed a pattern of: *perceived general benefits vs. perceived classroom integration difficulties* many of the level 1 interactions revealed a pattern where the benefits of the program were specifically tied to its classroom use (e.g. in terms of increased classroom variety) rather than balanced against it. This point is returned to in Chapter Nine.

Finally, two general points are worth making with respect to the level 1 interactions. The first is that the programs about which the interviewees were most enthusiastic were those which overcame problems they were experiencing in their teaching, e.g.

“Now that does look very, very useful. [It] would actually fulfil some of the syllabus requirements that we were going to find very difficult.” (Linda on *How Animals Move*)

“It’s a way of cross linking to different things, isn’t it? - it’s good for making connections to different areas, which [students] find really hard.” (Andrew on *The Ultimate Human Body*).

Such programs illustrate Draper’s (1998) concept of niche-based success; they were noticeably rare amongst the software pool. The second point is that although there was a fair degree of enthusiasm about the programs which the interviewees reviewed, these programs rarely matched with the ideal software the interviewees had outlined during the First Interviews. This point is addressed again in Section 8.6.

The next section examines how the interviewees said they would actually use the software in their teaching.

8.4 Using the programs in the classroom

The interviewees were asked to outline how they would use the program. They were able to do this without much problem, except in one case, as follows:

Would you use this in the classroom?

“Yeah. I’m not sure how until I have a good sort through it.” (Bill on Biodiversity).

The answers were variable in detail and focus, but several factors emerged with a degree of consistency. These included: who would control the interaction; whether the program would stand alone or would be used with worksheets and/or other activities; whether the material would have been covered beforehand; whether the students would be working singly or in groups; approximately how long the program would be used

for; whether the proposed structure of the activity had been constrained by the numbers of computers available in the teaching area. These factors are shown in Table 8.6.

Several themes emerged from Table 8.6.

a) The lack of computers was mentioned as a constraining element in 10 of the 24 cases, e.g.

“Again it's the whole idea of one CD-ROM machine ... the only way we could do that would be a circus of things for them to do, and this would be one of the things in the circus, and over a period of, say, 2 weeks they work their way round.” (Maria on *How Animals Move*).

b) The time that the computer would be used for was quite limited, ranging for the most part, from 10 to 20 minutes. This was sometimes clearly a response to the lack of computers (students would work in small groups, rotating to different activities during the class because there was only one computer) but it was also referred to as being the standard time for activity changes in order to keep learners motivated, e.g.

“Well, if I had an hour lesson I think I could use it for about ten minutes. It's just to keep the students enjoying the lesson. You wouldn't use it the whole time. You would just use it for ten minutes in an hour or so.” (Bill on *How Animals Move*)

c) In seven cases the interviewee mentioned that they would have the students working in small groups. Again, this may have been in response to the hardware constraints, but it was also likely to be for pedagogical value, e.g.

“I think this one they could have in turns, because of the lack of computers, ... I would guess on a full size screen you could have 2 or 3 playing on it at once - because it's quite good for them to knock ideas of each other anyway.” (Linda on *Mitosis and Meiosis*).

Table 8.6 How the interviewees would use the program

Program and interviewee	Who controls the interaction	Used as part of range of activities	Used with teachers' work-sheet	Material covered before-hand	Used singly or in groups	Time specified/ mins	Constrained by resourcing
<i>How Animals Move</i>							
Maria	S	✓	-	-	-	-	✓
Jim	S	-	✓	✓	groups	-	-
Pam	S	✓	-	✓	-	20	-
Bill	?	-	-	✓	1 group	10	✓
Linda	T					-	-
Linda	S	-	✓	×?	-	RS	-
Jean	T?					10	✓
Simeon	S	-	✓	-	-	-	-
<i>Biodiversity</i>							
Bill	-	-	-	✓	-	-	-
Angela	S	✓	✓	✓	-	-	-
Stephen	T					15	-
<i>Ultimate Human Body</i>							
Andrew	T						✓
Stephen	T					15	-
<i>Images of Biology</i>							
Andrew	S	✓	-	-	groups	-	-
Liz	S	✓	-	✓	singly	-	✓
Linda	S	✓	✓	-	groups	-	-
Phil	S	✓	-	-	either	RS	✓
Graham	T					-	-
<i>Mitosis and Meiosis</i>							
Andrew	S	✓	×	✓	groups	20	✓
James	S	✓	-	-	-	15-20	
Beth	S	✓	✓	-	groups	-	✓
Simeon	S	-	-	✓	groups	2-5	✓
<i>Recombinant DNA</i>							
James	S	✓	-	-	-	15-20	✓
Beth	S	×	-	×	singly	RS	-
<i>Swift-test</i>							
Phil	S	×	-	✓	-	up to 30	-

✓ = yes T = teacher - = no comment made RS = research session, therefore
 × = no S = student ? = unclear more than 30 minutes

greyed out = not applicable because session is teacher-led

d) In only two cases was it mentioned that the students might be working by themselves. These were both in research based sessions, and, again, it was noticeable that they were both proposed for GNVQ groups, e.g.

“For GNVQ they work on different areas, especially in the options - so you're not so in control of the whole class anyway - they have to get on with their own work and you're checking on them, and this would be excellent for somebody who is working through on their own.” (Beth on *Recombinant DNA*).

e) In nine cases the teacher stressed that they would have had to have covered the work first, e.g.

“I'd use it as backup after, probably, for two minutes, five minutes, after I'd already been through. ... I don't see a way of integrating that into a lesson to replace things I do now.” (Simeon on *Mitosis and Meiosis*).

f) In six cases the teacher stressed that they would get the students to use a work sheet while they were looking through the program. In some cases this was in order to manage a large program, e.g.

“I think I'd have to be very selective about what I'd present to the students ..because it's so big. You'd just give them their freedom and that's the end of the story. So you'd have to have it with a work sheet saying do this or that.” (Simeon on *How Animals Move*).

In other cases it was to add pedagogical value to a smaller program, e.g.

“So something like this, not actually on its own, but interactively, using worksheets or something.” (Beth on *Mitosis and Meiosis*).

Overall, there were three main ways in which the interviewees suggested they would use the programs. The most common approach was to have the students working in small groups, rotating around a number of activities, spending up to approximately 20 minutes on each, e.g.

“Um, I'd quite like to use this in the classroom, in terms of a sort of multiple activity .. where perhaps they were dealing with ... chromosomes ... and colchicine or something like that, coming through some text or information or pictures, ... electron micrographs

of different things .. taking notes from that and drawings and stuff like that, looking down microscopes, and then coming to this, and using this as part of one of those session where they'll spend, you know, 15, 20 minutes doing each different thing.” (James on *Recombinant DNA*).

The second most common approach was to have the computer linked to a projector, which was controlled by the teacher, who was using the program to illustrate a point, process or concept, e.g.

“In a lecture, you could do that one about sampling fish and so on, you could explain as an introduction the ideas of diversity, or even give them very little information in the beginning and then give them ideas based on that example and work through from there and get them to predict what the outcome could be before actually running them the simulation.” (Stephen on *Biodiversity*)

“It would be great for teaching I think, with *the teacher* using it ... as a display for teaching. Whether you'd want lots and lots of these for students to look at - part of me thinks they would be better off with the text book, and you having this to use as a display.” (Graham on *Images of Biology*).

The third way of using the program was when the students were working in a less time-constrained research session, on a more individual basis, e.g.

“I think it would have to be a research session. If they were asked to do some research on a certain topic - but you would have it in the classroom with some books available - you'd be unlikely to have enough PCs to go around.” (Phil on *Images of Biology*).

It was striking that the way in which the teachers used software during the observations (see Chapter Nine) was largely the way in which they said they would use the packages they reviewed here. This was true for Maria, Bill, Pam and Andrew. However, whereas the teachers' classroom dynamics during the observations showed some reflection of their philosophies of teaching and learning (see Section 9.3), it was not always the case that a teacher's degree of student-centredness was reflected in their suggested use of the software. For example, Graham had the most student-centred conceptions possible, yet the one program he said he would use, *Images of Biology*, he felt would be best used under teacher control. This pattern was clear in a number of

cases, where the teacher clearly felt that the program's use needed to be highly constrained for the students to get the most out of it.

The final point worth mentioning here is these teachers appeared to have clear and immediate ideas about how the program would fit into their normal classroom set-up. This aspect addressed in more detail in Section 8.6.

Section 8.3 looked at both the software and the interviewees as generic groups. The next two sections look at, first, the individual programs and, second, the individual interviewees.

8.5 A summary of the individual programs

In this section the interviewees' attitudes towards the individual programs are summarised.

1. *How Animals Move* was looked at by 12 interviewees. Seven said they would use the program in the classroom, two said they would use the program outside the classroom, one said he would not use the program at all, and two had an unclear rating.

The interviewees made many positive comments about this program. These included that the animations clarified some difficult concepts, the games were engaging, the games/simulations allowed exploration of areas which would otherwise be difficult to access (for example, how various factors can affect the anaerobic and aerobic balance during exercise). However the area in which the program was most praised was in the area of student engagement. Most of the comments made reflected the visual appeal of the program; for example, Jean talked about the "wonderful" video of the mandarin fish, Jim talked about the "marvellous" video and animation showing cytoplasmic streaming, and Linda talked about the "beautiful" depiction of muscular contraction.

Negative comments made about program focused on its limited use in different syllabuses; movement topics have recently been reduced on many A-level syllabuses. There were also practical concerns about how the program could be successfully integrated into the classroom, or the curriculum generally, bearing in mind the abundance of information, the lack of tight focus, and current levels of hardware resourcing. Some concerns were expressed about how far the program could be used to bring about effective learning, e.g.

“I think an awful lot of students would use this and look as though they're doing something, but actually it would transpire that they're just playing with things.” (Phil).

Most of those who said they would use the program in the classroom saw it being used either for short sessions with the teacher controlling the interaction and using the program to demonstrate a concept, or for longer sessions with the students controlling the interaction and using the program as part of a research session.

2. Biodiversity was viewed by seven individuals. Three of these said they would use the program in their classrooms and four said they would not use the program at all.

The program was not viewed in a particularly positive fashion. One individual particularly liked the simulations (on sampling and diversity). The other two quite liked its video facilities (for example in the classification section) and its animation facilities (for example in the immunology section), but saw the program primarily as a source of classroom variety.

The negative comments which were made about the program generally centred on its lack of interactivity; much of it was seen as a mass of hypertext pages, and therefore not particularly engaging for students. One interviewee also commented that the information was inconsistent in terms of level of difficulty.

Of the three who said they would use the program in the class, one said he was unclear exactly how, one said she would use the program as part of a range of activities in order to provide a different resource for looking at classification, and one said he would integrate the simulation aspects of the program into a lecture to clarify processes to do with sampling.

3. *The Ultimate Human Body* was looked at by seven individuals. Two said they would use it in the classroom, four said they would use it outside the classroom, and one said he would not use it at all.

Positive comments which were made about the program included praise for the clarity, graphics, "friendliness" and usability. Two of the interviewees were particularly struck by the interlinking of information, which they felt would be useful for helping students to make connections between different parts of the syllabus.

Two of the teachers commented that the program was rather dull. Other than these, most of the negative comments about the program concerned its lack of depth of information; the teachers generally felt that the information was pre-GCSE. However, other than Gary (who taught at degree level and therefore felt he had no use for the program) most of the interviewees said they would be happy to suggest their students use the program in the library as an introduction or for backup.

Of the two who said they would use it in the classroom, both felt it would be appropriate for the teacher to control the interaction and use the program as a demonstration source.

4. *Images of Biology* was looked at by seven individuals. Five of these said they would use it in the classroom, one said she would use it outside the classroom and one said he would not use it at all.

Several of the interviewees had seen the program before, and others had heard about it and were keen to try it. This was primarily because the program was designed to accompany a well known A-level biology book.

Several positive comments were made about the program's visual clarity, the benefits of combining sound and vision, and the ease of manipulation. Three interviewees stressed that students would benefit from being able to control the interaction, and one felt that the ability to move backwards and forwards within the program allowed students to build up a picture of

"The way in which things relate to one another ... Once you understand how to put 2-D and 3-D together then it's okay. " (Judy).

Positive comments were also made about the video and animation facilities, and the fact that traditional microscopy (which this, to some extent, replaces) can be frustrating and time-consuming.

Negative comments about the program largely centred around the fact that it was seen as very limited, and a wasted opportunity e.g.

"Somebody has got on the bandwagon of producing a CD just doing what we've been doing and just sticking a couple pictures on the CD, and that's not what we [want]."
(Mark).

Two individuals stressed that the video and animation facilities were under-used, and that traditional microscopy was more valuable, or video microscopy more usable.

The five who said they would use it in the classroom saw themselves, in four cases, using it as part of a range of activities, often in combination with other microscopy activities. In one case the interviewee said he would use it for demonstration purposes only.

5. *Mitosis and Meiosis* was looked at by six individuals. Four said they would use it in the classroom, one said she would use it outside the classroom, and one said he would not use it at all.

This program was very small by comparison with the other programs, and the information it contained was directly relevant to all A-level biology syllabuses. This was reflected by most of the positive comments which tended to centre on the fact that the program's size meant it was easy to navigate and the information was to the point. A couple of the interviewees stressed that the animation aspects were useful in stressing the continuity of what was often viewed as a static process, and a couple emphasised that the program was valuable simply in giving a change of activity, or in allowing students to work at their own pace.

Negative comments about the program included that it was only minimally interactive, and resembled a "moving textbook" (Bruce), which failed to address some of the key aspects of meiosis (particularly the formation of chiasmata) and failed to give any emphasis on the significance of cell division.

The four who said they would use the program in the classroom all saw themselves using it as part of a range of activities with the students working in small groups and using it to supplement information acquired in the rest of the session.

6. *Recombinant DNA* was looked at by six individuals. Two said they would use it in the classroom, two said they would use it outside the classroom and two said they would not use it at all.

Positive comments about program were to do with the topic area and the clarity and accessibility of the information it contained. The program was seen as being valuable because this information was not readily available in standard textbooks, despite

appearing increasingly on various biology syllabuses. The two individuals who said they would use the program outside the classroom noted, in one case, that the program was essentially best used by students during private study, and in the other case, that it was too time consuming for classroom integration.

The two who would not use the program at all complained about the lack of student engagement because of the lack of interactivity. One of these interviewees was very emphatic about this and stressed that he could see no point at all in programs like this. The other was less emphatic but also felt that the program was difficult to navigate, and would be difficult to integrate into the curriculum.

7. *Biological Simulations* was looked at by five individuals. None said they would use it in the classroom, one said he would use it outside, three said they would not use it at all and one had an unclear rating.

The positive comments made about the program were more to do with these interviewees' positive perspectives on simulations in general. This was particularly evident in Mark and Peter's accounts. These two were highly critical about programs which were essentially book-like, and they felt that this program was at least attempting to encourage greater interactivity. Peter also found its simplicity very appealing, particularly by comparison with what he felt were the complex and potentially distracting interfaces on many modern programs.

However most of those who looked at the program, including Mark and Peter, thought that it was too dated to appeal to students. This criticism was targeted both at the interface and at the design of the activities. Of the three interviewees who would not use the program at all, two felt it would be boring, and the third had concerns about the accuracy of the representations.

8. *Swift-test* was looked at by three individuals. One of these said she would use the program in the classroom and two said they would use the program outside the classroom.

All three found the initial idea of the system very appealing. They felt that it could be used by students independently to give them practice in, and feedback on, answering A-level biology questions. Phil, who said she would use the system in the classroom, thought it might be useful and fun to use in order to give the students a bit of variety. Of the other two, one felt it was essentially boring but might be useful for revision purposes, the other felt that it was too inflexible to be used in class. Both these complaints were echoed by another teacher who had bought the system, but felt it could not be used until it was altered. The lack of flexibility centred around the fact that the students had to complete a very extensive range of questions in a fixed order before feedback was given.

9. *SimEarth* was looked at by three individuals all of whom said they would use it outside the classroom. This program is fairly complex, and the interviewees felt it was difficult for them to get a good sense of how useful the program would be. However they all decided that the degree of complexity meant that they were unlikely to use it in the classroom.

Once again, the simulation aspect was viewed favourably, and the extensive coverage of biological phenomena was thought to be potentially very useful. The interviewees said they would suggest the students use the program outside the classroom, variously, for revision and reinforcement, as an interesting diversion and to aid understanding. Negative comments were to do with the degree of complexity, and concerns that the program would be time consuming and insufficiently focused for classroom use.

10. *Darwin's Voyage* was looked at by one individual who said he would use it outside the classroom. He felt that it would be interesting to browse through but too time-consuming for classroom use.

11. *GenScope* was not from the original pool. It was looked at by one individual who said she would use it outside the classroom. She had concerns about the level of complexity and whether this would confuse students, but also felt that the program could be both valuable and exciting to use with students in a resource centre. Her concerns about using it in the classroom were to do with resourcing, classroom management, and the fact that she felt the program was inherently designed for use outside classrooms.

12. *Body Insight* was not from the original pool. It was looked at by one individual who would not use it at all. The one positive comment he made about the program was that students could use it independently once they had got used to the interface. However initially he found the interface very unhelpful, and he felt that the information was unduly specialised and inconsistent in level.

13. *Australian Fishes for Aquariums* was not from the original pool. It was looked at by one individual who would use it outside the classroom. She was particularly pleased to have come across this program, because it covered relevant topics which were difficult to find elsewhere, and was very cheap. She felt the program would be best used outside the classroom, and could not see any way to use it effectively as part of a classroom activity.

8.6 The individual teachers

In this section the attitudes of the individual interviewees are explored to try to establish how their views of software were affected by their personal characteristics.

In Section 8.2.2 it was noted that there was considerable variation between individual interviewees in their evaluations of the software. This was so even when they were teaching to apparently identical syllabuses. For example, Bruce, Judy and Graham all taught A-level biology. They were all interested in reviewing *Images of Biology* because it was associated with a standard and well-known A-level textbook. However, their assessments of the program differed widely, with Graham concluding he would use it in the class, Judy concluding she would use it outside the class and Bruce concluding he would not use it at all.

Bruce's objections to the program were twofold. The first was that the information was presented on a surface level which did not encourage students to identify the underlying significance of biological structures and processes and instead encouraged simple acceptance. The second was that the program was designed to replace a useful, and more effective activity:

"With biology nowadays it's more the functional approach; this is more towards the histology side, just showing slides, which you could see far more effectively down microscopes, and you could get the students practising using the microscope rather than CD-ROMs - so it's not material I would have chosen to put on a CD-ROM ... No I'm not awfully impressed with this."

Graham also addressed the issue of "real" versus "virtual" microscopy, but came up with different conclusions:

"With prepared [microscopic] slides, some students get the good one and some students get the dud ones ... and they spend so long trying to operate the microscope that it can often get in the way ... You could [use this program to help them understand what is going on and then] actually teach microscope skills as a separate thing ... [However the program needs] more of a 3D effect, because [that's] one of the biggest problems students [face when trying to] connect to what's going on. I always think that is a difficulty for a student, and you can make great assumptions about that as a tutor."

Graham decided that he would use the program in the classroom, but primarily for demonstration purposes, so that he could compensate for the areas in which he felt the program was lacking.

Judy also focused on the students' 2D/3D problems, but felt the program could be usefully used as it stood to address these:

"Students find it hard to put the microscopy image into something that is three dimensional ... I think this is nice ... once you understand how the 2D and 3D fit together then it's OK ... [Students could] use [the program] to recognise when they do and don't know something ... and to move back and forth and build a picture."

However, Judy decided she would not use the software in the classroom because she felt that (as always, and regardless of the specific software) poor resourcing was problematic and led to classroom management problems.

Although there was considerable variety in the criteria which were used to judge each piece of software, there was considerable consistency in the criteria used by each interviewee across all three programs they looked at. For example, Bruce, in the quote above, criticised the stance from which the material in *Images of Biology* was written.

Similarly, with respect to *Mitosis and Meiosis* he noted:

"It should also be stressing the biological significance more, all it's doing is giving a load of facts".

Bruce applied the same criteria to *Recombinant DNA* and concluded that he could find a use for it, because the structure and the information clarity would allow the students to explore the topic in-depth and get to grips with the underpinning significance.

There was only one case where the interviewee's perspective clearly shifted during the interview so that she came up with different areas of criticism or praise for each program. This interviewee was Liz, who was unusual amongst the group in that she was looking at software for the very first time. The others all had some experience in

using software and appeared to focus on specific areas of concern which related to their teaching concerns.

To some extent the interviewees' different attitudes towards the software represented different teaching concerns which seemed too variable to be classified. However, there were two factors which emerged from the Second Interviews as having a clear impact on the interviewees' decisions about whether or not to use the software they were reviewing. The first of these was whether the interviewee could consider adapting the use of the program to fit in with their teaching, and the second was the interviewee's degree of teacher- or student-centredness, as follows.

Table 8.7 shows the rankings for the three pieces of software each interviewee reviewed. In this table the interviewees have been placed in order, with those who were most likely to use the software in the classroom being listed first. So, for example, Andrew, who said he would use all three programs he reviewed in the classroom, is listed first, and Bruce, who said he would not use any of them in the classroom, and would not use two of them at all, is listed last. The three individuals who had uncertain rankings (Angela, Peter and Gary) are also listed; Angela and Peter's uncertain rankings were borderline 1 or 2, and they are positioned accordingly. The interviewees' conceptions for teaching and learning are also listed. The individuals in the shaded rows are those who were able to consider adapting the program's use, as discussed later.

Table 8.7 The individual teachers' software ratings and their philosophies of teaching and learning

Interviewee	Rating of software	Conception of learning	Conception of teaching
Andrew	1, 1, 1,	C	C/D
James	1, 1, 2,	C	C/D
Bill	1, 1, 2,	A	B
Stephen	1, 1, 2,	C	D
Phil	1, 1, 2,	C/D	D/E
Angela	1, *, 2,	C	A
Beth	1, 1, 3,	C	C
Linda	1, 1, 3,	E	F
Jim	1, 2, 2,	C	C
Maria	1, 2, 2,	C	A
Liz	1, 2, 2,	B	C
Jean	1, 2, 3,	C	C
Pam	1, 2, 3,	B?	C?
Simeon	1, 2, 3,	D	E
Graham	1, 2, 3,	E	F
Peter	*, 2, 3,	C/D	D
Judy	2, 2, 3,	D	E
Gary	*, 3, 3,	E	F
Mark	2, 3, 3,	C/D	D
Bruce	2, 3, 3,	E	F

* = uncertain software ratings (see Section 8.2.1)

? = uncertain teaching and learning classification (see Section 6.2.4)

Overall the table shows that the interviewees who were less likely to use software in the classroom were also more student-centred. The shaded individuals interrupt this pattern to some degree for reasons discussed later, but the pattern is even more marked when the two sets are separated out, as shown overleaf.

Interviewee	Rating of software	Conception of learning	Conception of teaching
James	1, 1, 2,	C	C/D
Bill	1, 1, 2,	A	B
Angela	1, *, 2,	C	A
Jim	1, 2, 2,	C	C
Maria	1, 2, 2,	C	A
Liz	1, 2, 2,	B	C
Jean	1, 2, 3,	C	C
Pam	1, 2, 3,	B?	C?
Peter	*, 2, 3,	C/D	D
Judy	2, 2, 3,	D	E
Gary	*, 3, 3,	E	F
Mark	2, 3, 3,	C/D	D
Bruce	2, 3, 3,	E	F

Andrew	1, 1, 1,	C	C/D
Stephen	1, 1, 2,	C	D
Phil	1, 1, 2,	C/D	D/E
Beth	1, 1, 3,	C	C
Linda	1, 1, 3,	E	F
Simeon	1, 2, 3,	D	E
Graham	1, 2, 3,	E	F

The link between critical attitude towards software and student-centredness was first tentatively proposed in the pilot study (see Section 6.4), in which it was also suggested that there were two possible explanations for the apparent relationship. The first was that if there was a mismatch between the teacher's and the software's (or, strictly speaking, the software designer's) philosophies about education, then this could have an important effect on the teacher's perception of the software's usefulness. The second was that the less student-centred individuals might simply have had less of a *focus* on pedagogical issues, which is why their conceptions lay in the middle range. It

was suggested that if this was the case then it was not so much that their pedagogies *matched* the program's pedagogies, but just that this was less of an obvious issue for them; they considered a program valid even if there was a mismatch.

The main study findings suggest that both these explanations have some merit. Firstly, it was clear that many of the student-centred individuals assessed the programs in a way which reflected their student-centredness. For example, Bruce, Judy and Graham were all very student-centred, and the way in which they reviewed the programs (see previous quotes on *Images of Biology*, pp 289-90) demonstrated a strong focus on the students' experience of the subject matter, and how the software might impact on this. This strong focus was less evident in the more teacher-centred individuals. However, there was no evidence that these individuals required the programs to fit in with a specific teacher-centred perspective, and therefore it did indeed seem as though they considered a program valid even if there was an apparent pedagogical mismatch.

However, there were a number of individuals who were student-centred, and who identified a mismatch between their own and the program's pedagogies, but who still suggested they would use the program in the classroom. Graham was one of these; he had reservations about *Images of Biology*, but felt that he could use it in the classroom in a way which allowed him to overcome these reservations. His experience contrasted with Judy's (see also previous quote); she was more enthusiastic about the program, but felt she could not use it, or indeed most software, effectively in the classroom.

Only seven of the interviewees suggested that they could modify a program's use and therefore overcome perceived shortcomings, these individuals are those who were shown in the shaded rows in Table 8.7. Although these "modifiers" were often critical

about the software, they none-the-less suggested how different types of use could overcome perceived problems, e.g.

“That's pretty disappointing actually, I thought it would show the motion. You'd get minimal text with these, but I suppose if you're using it with the book it doesn't really matter, you'd use the two things together” (Andrew on *Images Of Biology*, level 1)

“It's a shame, ideally you'd want to see the whole process together with the text, so that they've got a chance to see a phase, stop a phase, but I'm perhaps being a bit greedy. It's a nice calibre of graphics and clear pictures. I want it to sing and dance I suppose ... perhaps how you should use this one is to use it with, say, a set of notes so that they've got to annotate their own set of line drawings from what they get on the CD-ROM.” (Linda on *Images Of Biology*, level 1)

“So it's not the all singing, all dancing, all colour, that I expected. [It lacks interactivity but it could be useful for the students because] if they're not sure what they're looking at they can stop it, have a look, and make sure it all fit together. So something like this, not actually on its own, but interactively, using worksheets.” (Beth on *Mitosis and Meiosis*, level 1)

“If I had [the program] I would try to use it. [But] I think the students would be having a nightmare trying to get started ... I might try to use it in the classroom with very specific instructions, where I would get them to do a specific act and then talk about that afterwards. I suppose I would use it that way. But that doesn't strike me as the way it's intended to be used.” (Graham on *SimEarth*, level 2).

Some striking results were obtained from examining the modifiers' exposure to computers in HE and exposure to computer-using colleagues. These are shown in Table 8.8a, and the same variables are shown for the non-modifiers in Table 8.8b. As can be seen, all of the modifiers had used computers in HE, and most of them felt that they had colleagues who were using computers effectively in their teaching. By comparison, less than half the non-modifiers had used computers in HE, and only one of the 13 non-modifiers felt they had effective computer-using colleagues.

Table 8.8a The modifiers' HE exposure and computer-using colleagues

Interviewee	Rating of software	Used computers in HE	Had effective computer-using colleagues	Current level of CAL use
Andrew	1, 1, 1,	✓		monthly
Stephen	1, 1, 2,	✓	✓	rare
Phil	1, 1, 2,	✓	✓	occasional
Beth	1, 1, 3,	✓	✓	monthly
Linda	1, 1, 3,	✓	✓	occasional
Simeon	1, 2, 3,	✓		none
Graham	1, 2, 3,	✓	✓	monthly

Table 8.8b) The non-modifiers' HE exposure and computer-using colleagues

Interviewee	Rating of software	Used computers in HE	Had effective computer-using colleagues	Current level of CAL use
James	1, 1, 2,			monthly
Bill	1, 1, 2,			rare
Jim	1, 2, 2,	✓		none
Maria	1, 2, 2,			monthly
Liz	1, 2, 2,			none
Angela	1, *, 2,		✓	occasional
Jean	1, 2, 3,	✓		rare
Pam	1, 2, 3,			*
Peter	*, 2, 3,	✓		weekly
Judy	2, 2, 3,	✓		rare
Gary	*, 3, 3,	✓		rare
Mark	2, 3, 3,			rare
Bruce	2, 3, 3,			none

✓ = yes * = unclear

It is worth stressing that none of the modifiers suggested they would radically alter their usual teaching patterns in order to incorporate the software. Such suggestions

would have been surprising, bearing in mind that the interviewees only had a relatively short time to react to each program. However, it may also be that the programs which were included in the pool were not seen as pivotal enough to the interviewees' teaching to merit such alterations; this point is addressed in more detail in Chapter Nine.

In summary

- The more student-centred teachers were, in general, more critical about the software and less likely to use it in the classroom. These criticisms were often directly related to the interviewees' student-centred concerns.
- The less student-centred teachers were, in general, less critical about the software and more likely to use it in the classroom. There was no evidence that this was related specifically to their more teacher-centred concerns, therefore it appeared that these individuals simply had less of a focus on the type of pedagogical concern picked up by the Prosser et al (1994) classification scheme.
- Individuals who were able to consider modifying the use of a program in their classrooms were more likely to use it even if they were critical about it. This modifying ability appeared to be related to whether the teacher had had HE exposure to computers, and had effective computer-using colleagues. It seems likely that possession of this ability may also have developed through the teacher's own use of CAL.

8.7 Conclusions

The overall enthusiasm for the software reviewed during the Second Interviews was quite surprising, particularly after an examination of the gap between what these programs provided and what the interviewees said they wanted CAL packages to provide (see Section 7.5.3). During the Second Interviews the most common reason

given for using a program outside the classroom (level 2) was for revision or reinforcement; only three out of nineteen¹ interviewees mentioned using software for such purposes when talking about their ideal CAL. Similarly, two of the most common reasons given for using CAL in the classroom (level 1) related to whether the program was visually appealing or could be used to provide classroom variety. Once again these aspects received minimal attention when the interviewees were describing their ideal CAL.

Despite this gap many of the teachers appeared keen to integrate the software provided into their teaching. This could have been because of their reluctance to offend the researcher. However, this seems unlikely as the interview stress was clearly on evaluation of the software rather than a sales pitch. It could also have been because the software

- a) was already provided
- b) was usually appropriate for the syllabuses the interviewees taught
- c) worked on the hardware provided.

The corresponding ease of use may have made many of the teachers more prepared to adjust their demands accordingly, and be less adamant that the software should be able to do something not done by their traditional resources. Graham illustrated this point nicely, as follows:

“If I had it I would try to use it. But would I go out and buy it? That is the question”
(Graham on SimEarth).

This second reason may also give an added explanation as to why there was increased use of CAL amongst those who believed their colleagues were using CAL

¹ Nineteen, rather than 20 interviewees are mentioned here because one of the interviewees felt she had no idea what might make CAL packages appealing to her.

effectively; if someone else is bearing, or helping to bear, the very large burden of supplying software and hardware then teachers may be more prepared to consider using it, even if it does not match up to their ideals. This is illustrated in Figure 8.1, overleaf, which shows possible ways in which the factors on the obstacle course can interact to increase teachers' CAL use, and represents a further modification of Figure 7.2 (Section 7.8). Other added links in Figure 8.1 are explained in the rest of this section.

In Chapter Seven it was proposed that individuals who had effective computer-using colleagues and who had had exposure to computers in HE showed an increased CAL use because these factors contributed to their general familiarity with the use of computers in teaching. The identification of the “modifier” group in Section 8.6 gave added strength to this proposal, and demonstrated that one of the mechanisms by which this increased familiarity could act to bring about increased CAL use was by showing teachers how less-than-ideal software could be used in ways which overcame its perceived shortcomings. Again it appeared that the development of this classroom familiarity was greatly enhanced in those who worked in relatively open departments which included an exchange of ideas about teaching practice.

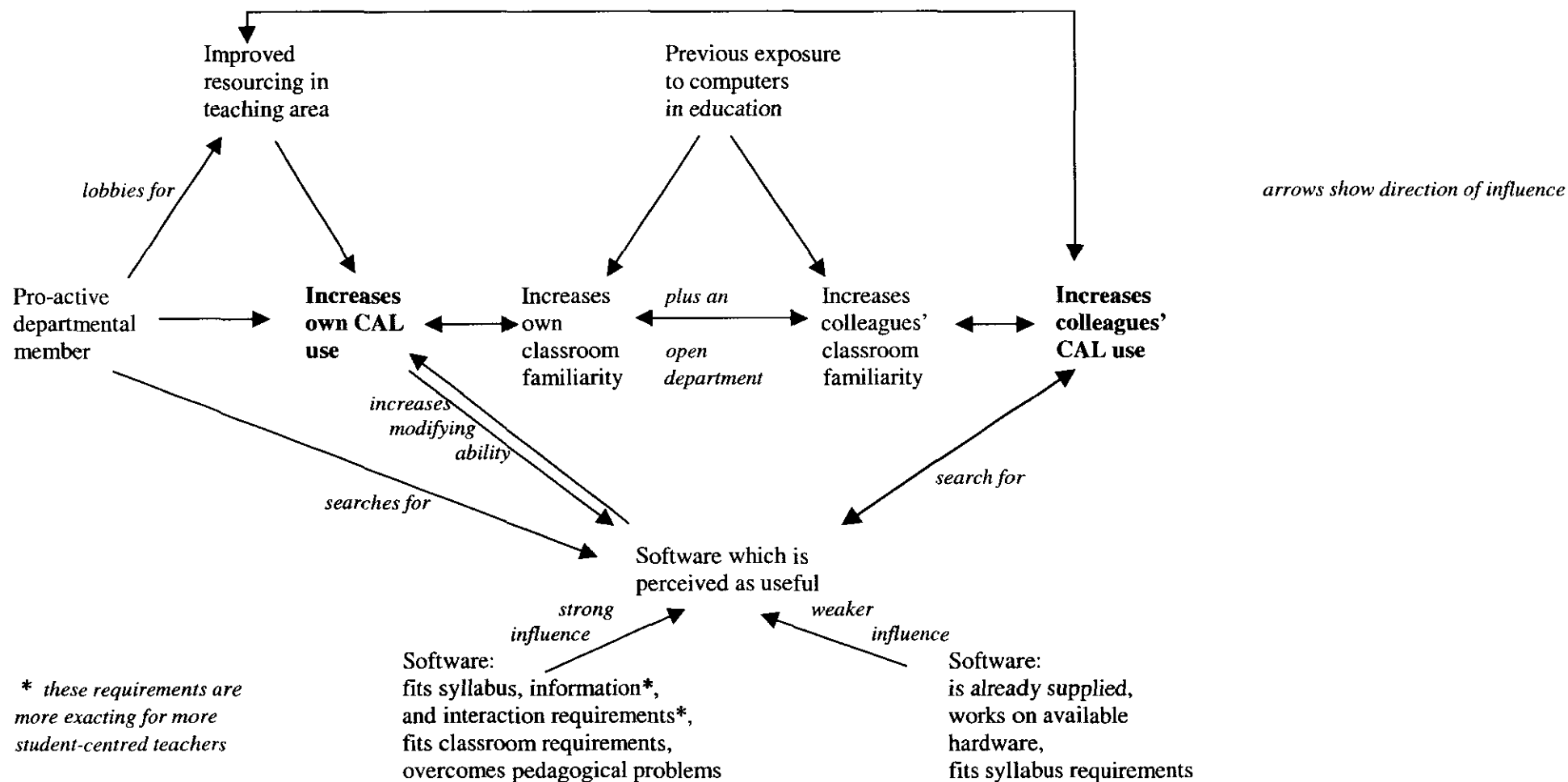


Figure 8.1 Grappling with the obstacle course: how the perceived usefulness of CAL affects the picture

The findings from the Second Interviews suggested that in order for the interviewees to perceive specific programs as useful, they needed to

1. fit into their syllabus area
2. meet their demands for information quality in terms of clarity, consistency and, where appropriate, pedagogical slant **or** have the potential to be used in a way which could overcome any shortfall
3. meet their demands for user engagement **or** have the potential to be used in a way which could overcome any shortfall
4. demonstrate a value which meant it would be worth using in the classroom despite integration problems (e.g. time) **or** demonstrate a value specifically for classroom use (e.g. in enabling students to work independently in a classroom setting, or adding variety)
5. (as a considerable bonus) overcome a specific pedagogic problem.

It was noted that the interviewees were particularly keen on software which satisfied criterion 5, but that such software was rare amongst the pool. It was also noted that the above criteria seemed to be applied in a more exacting fashion when the interviewees were considering how they might use the software in relatively traditional classes, such as A-level, which were primarily examination oriented, very information dense and subject to considerable pressures in terms of time (see Section 8.3.2). It appeared that such classes, because of these constraints, were perceived to be less conducive to the extensive or imaginative use of educational technology. A similar observation was made following the analysis of the First Interviews (see Section 7.5.3), where it appeared that the most creative uses of CAL were those which the teachers said they would use *outside* traditional A-level or equivalent, classroom-based sessions; this emerges again in Chapter Nine.

It has already been emphasised (see Section 6.1.2) that biological software which is targeted at A-level or equivalent was, at the time the software pool was being gathered, neither abundant nor easy to access. This was particularly evident by comparison with the number of biological programs being developed within HE and information dissemination about these programs via the CTI. The situation within FE is changing, and more information is being made available via the newly established FERL website². However, by the end of 1998 this website still only contained information about four biology multimedia packages and two biology web-based programs. The situation is also changing as more programs are being developed in-house, particularly under the influence of the QUILT programme. However, most of the QUILT development projects appear to be targeted at cross-college initiatives³ (such as the development of key skills) rather than at subject-specific curriculum delivery (Barnard, 1998b).

Chapter Eight concentrated on the interviewees' perceptions of the usefulness of relatively inexpensive programs which were easy to demonstrate on portable machines. Chapter Nine details observations of teachers using such programs, and also includes observations of teachers using applications which could not be included in the software pool. Therefore additional information emerges from Chapter Nine about teachers' perceptions of the usefulness of these other types of software.

² Further Education Resources for Learning (<http://ferl.becta.org.uk>).

³ <http://feda.ac.uk/QUILT/CollegeProjects98>

Chapter 9: Main Study Classroom Observations

The observations aimed to investigate the nature of the interviewees' classroom dynamics and how these impacted on their use of CAL. Nine observations were carried out in total, three as part of the pilot study and six as part of the main study. This chapter describes all nine together under the following headings.

Section 9.1 *Some practical aspects*. The findings from the pilot study had an impact on the way in which the main study observations were carried out. This section outlines that impact, and also describes some additional practical aspects to carrying out the observations.

Section 9.2 *The observation group*. Here the main features of the observation group are outlined and compared with the interviewee group.

Section 9.3 *Some general features of the sessions*. This section outlines the range of the classes observed in terms of, for example, software used, numbers of computers available and general organisation.

Section 9.4 *Analysis within the Brown and McIntyre (1993) framework*. This section analyses and compares the sessions using the Brown and McIntyre framework. It focuses particularly on the shifts in Conditions, Progress and NDS evident in the accounts.

Section 9.5 *Conclusions*. This section summarises the findings from the analysis and discusses the methodological implications of the study for further research.

9.1 Some practical aspects

This section consists of two parts. The first examines the modifications to the main study observations in the light of the pilot study findings. The second outlines some additional practical details.

9.1.1 Modifications to the observations in the light of the pilot study

The organisation and analysis of the First and Second Interviews was relatively unchanged between the pilot study and the main study. The observations, however, were changed significantly in the light of the pilot study. The pilot study findings were detailed in Chapter Six and are summarised in this section.

The initial, tentative aim was to carry out single observations with a total of five of the interviewees; three from the pilot study and two from the main study. The intention was to analyse the observations according to the Brown and McIntyre (1993) framework, and the structure of the observations was therefore based on a modified version of Brown and McIntyre's (1993) methodology (see Section 5.5.3). This involved an initial session during which the teacher was videotaped while they used software in their teaching, and a follow-up session where they reviewed the videotape and talked generally about what was happening during the class. In the pilot study this procedure was carried out with three of the interviewees, Andrew, Jim and Pam.

The analysis of the pilot study observations was based on the recordings and transcripts of the comments the teachers made during the follow-up session, and on the researcher's own observations. The analysis was carried out firstly according to the general guidelines outlined in Section 5.7, and secondly within the Brown and McIntyre (1993) framework. The structure of the main study observations was guided by the following points which emerged from the pilot study observations.

1. The 'general' analysis of the teachers' comments, which was based on the guidelines outlined in Section 5.7, revealed a large number of variables which appeared to influence the teachers' decisions about whether and/or how to use software in the classroom. These variables appeared too numerous to allow for many generalised comparisons to be made.

In contrast, the Brown and McIntyre (1993) concept of NDS appeared to provide a useful overarching structure within which the teachers' different experiences of using CAL in their classrooms could be examined. Therefore it seemed appropriate to focus on this concept in the analysis of the main study observations. However, a great deal of additional information emerged from the *general* analysis which was not encompassed by the NDS, and it appeared that other concepts from the Brown and McIntyre (1993) framework, such as Progress and Conditions, might be useful when analysing the teachers' comments.

2. Many aspects which emerged from the comparison of Andrew, Jim and Pam's accounts appeared to be very context based. Therefore it was decided that it would be useful to observe the same teachers a second time, while they were teaching different syllabus areas and using different software. This would also provide more information about the stability of the teachers' NDSs across different classes at different times, and possibly show the development of NDSs in a relatively inexperienced teacher, Jim. To add to this, it was thought it would also be valuable to increase the range of teachers involved in the observations, and carry out single observations with an additional three.

3. The pilot study observations involved teachers using programs which were new to them, and which came from the pool provided by the researcher. It was decided that the main study observations should involve, as far as possible, teachers using software which was under-represented in the software pool (e.g. experimental interfacing, data analysis and the Internet), and/or which they had used before. This meant the software, and the hardware to run it, would have to come from the teachers' departmental resources, rather than from the researcher. It was hoped that this facet would provide additional information about the impact of any resourcing constraints and technical difficulties.

9.1.2 Other practical details

In total, three teachers were observed once and three twice. Unfortunately it was not possible to arrange a second observation with Jim, and so one of the teachers from the main study was observed twice, instead of him.

The observations were very spread out, and took place over a period of 20 months (see Table 9.1). This was because their timing was essentially dependent on when the teachers were covering appropriate parts of the syllabus. This was in turn affected by other factors such as FEFC inspection and sick leave. The timing of the follow-up sessions was also variable (see Table 9.1), and depended on timetabling constraints and the teacher’s general workload. The aim was that the follow-up session should take place as soon as possible after the observed session. In four cases there was a gap of several weeks, and under these circumstances the videotape proved to be not just a useful prompt, but absolutely essential.

Table 9.1 Observation and follow-up session dates

Teacher	Observation date	Gap between observation and interview
Andrew 1*	December 96	2 weeks
Jim*	February 97	None
Pam 1*	February 97	3 days
Pam 2	November 97	1 week
Bill	November 97	3 weeks
Mark 1	January 98	5 weeks
Mark 2	May 98	4 weeks
Andrew 2	June 98	None
Maria	July 98	None

1 = first observation
2 = second observation
* = observations which were analysed for the pilot study (see Section 6.6)

The observations and follow-up sessions were fairly straightforward. The video camera was set up in the classroom as unobtrusively as possible so that it could record the general classroom activities, rather than just the computer activity. For the most part it was used to track what the teacher was doing. Sometimes it was left to run by itself when it seemed as though the students nearby were being distracted by the researcher's presence. During the session the researcher sketched the overall room layout and took brief notes on the classroom activities and timings. The researcher was sometimes drawn into the class and asked by the students or the teacher to provide information or assistance, in which case she complied with the requests as unobtrusively as possible. In each case one hour of the class was videotaped; if the class was longer than this then advice was sought from the teacher about which hour would be the most appropriate.

During the follow-up session the teacher was asked to comment on the videotape. The following is typical of the way in which the request was framed and is taken from the follow-up session for Pam's first observation:

"I'd like you to look at what's going on and pretty much talk about it in terms of what you're doing, why you're doing it, any feelings you have about what's going on there – what works, what didn't work, and how integrated the activities were, which activities you were pleased with – anything that crops up while you're looking through."

In several cases the teachers were very expansive. In other cases they needed to be prompted, and were asked questions such as "Do you often organise the class in this way?" or "What's happening now?". For the most part the teachers dictated the direction of the follow-up session, so that even if they were moving away from the point they were not interrupted.

Following the analysis, a paper showing the findings was sent to four of the observed teachers, Andrew, Pam, Maria and Mark, with a request that they read it and

comment on how far the analysis matched their experience of using the software.

Responses were received from Andrew, Maria and Mark.

9.2 The observation group

Table 9.2 shows a profile of the six observed teachers, based on factors which emerged from the survey and interviews as being important with respect to CAL use.

Table 9.2 Profile of the observation group

Teacher ‘	Information from the survey				Information from the interviews		
	Years in teach- ing *	Access to comp- uters in HE	Frequency of CAL use *	Number of computer applications used at home and at work	Conception for learning and teaching	Do they have computer- using colleagues?	Software ratings
Andrew	8	✓	monthly	1, 1,	C C/D	DK	1, 1, 1,
Jim	1	✓	none	2, 5,	C C	×	1, 2, 2,
Pam	16	×	n/a**	6, n/a**	B? C?	×	1, 2, 3,
Bill	22	×	rare	2, 3,	A B	unclear	1, 1, 2,
Mark	15	×	rare	5, 3,	C/D D	unclear	2, 3, 3,
Maria	17	×	monthly	3, 2,	C A	DK	1, 2, 2.

✓ = yes × = no DK = interviewee did not know
* = at the time of the survey
** at the time of the survey Pam did not have a computer at work, therefore questions about her CAL use and use of other applications at work were not applicable.

When the observations were first being planned there were concerns that the only interviewees who would volunteer to be observed were those who were expert and confident in using software in the classroom. In the event this was not so, and Table 9.2 shows that the observed group was made up of teachers whose CAL use, at the time of the survey, ranged from “none” to “monthly”. In fact, by comparison with the general interviewee group, the observed teachers had proportionally less exposure to computers in HE, and did not have colleagues who they felt were using computers well. This

combination was found from the survey and First Interviews to be linked with a less frequent use of CAL.

Other than this their attitudes towards CAL (as judged by the software ratings) and their conceptions for teaching and learning were broadly representative of the interviewee group. It would have been useful to have been able to include one or more individuals with the most student-centred classifications. It would also have been useful to have included more than one software “modifier” (see Section 8.6) amongst the observed teachers; Andrew was the only one included here. However, selection of the observation group was already too highly constrained to allow for additional exacting requirements.

9.3 Some general features of the sessions

The nine observations involved classes working at fairly similar levels, particularly the A-level and Access classes. One GNVQ Intermediate class was also observed, which involved generally younger students working at a lower level. The classes were very variable in terms of student numbers, ranging from two to 21; in general the student numbers lay between 15 and 20.

All except one of the classes took place in biology laboratories which constituted the teachers’ usual teaching area. The exception was Mark’s second observation, which took place in a computing suite. This class was rather unusual in that it was part of an “enrichment” program on control technology designed to supplement science students’ more conventional A-level programmes. The other classes all involved straight biology. In all cases except one the class was part of the teacher’s normal timetable. The exception was Andrew’s second observation; he had been off sick for several months and returned towards the end of the year, too late to pick up his normal classes. This class was one he was taking for a colleague.

The software which was used covered a good range (see Table 9.3) and the nine observations involved:

- three classes using tutorial aspects of CD-ROMs
- one class using a non-CD-ROM tutorial package
- two classes using experimental interfacing
- one class using a data analysis program
- one class using programming/modelling
- one class using the Internet.

In four cases the observation involved the teacher using software they had not used in the classroom before.

Table 9.3 The range of software used in the observations

Teacher	Type of software	Had they used the software before?
Andrew 1*	Tutorial	×
Jim 1*	CD-ROM/tutorial	×
Pam 1*	CD-ROM/tutorial	×
Pam 2	Internet	✓
Bill	CD-ROM/tutorial	✓
Mark 1	Experimental interface	✓
Mark 2	Programming/ modelling	✓
Andrew 2	Experimental interface	×
Maria	Data analysis	✓

* = pilot study participants
✓ = yes
× = no

1 = first observation
2 = second observation

In seven of the observations the teacher only had access to one computer; the two exceptions involved Mark’s classes, where he had two computers in his first observation, and 15 in his second. The classes were variable in terms of the time each

student spent using the software. This ranged from five minutes (for the data analysis program) to the full hour (for the experimental interface and programming software).

There was a marked degree of consistency in the way in which the classes were set up, and the organisation of many sessions was very similar to the main mode of use suggested by the interviewees during the Second Interviews (see Section 8.4). It seems likely that that this was largely determined by the number of computers available per student, as follows:

- a) Where there were 12 to 18 students and only one computer, the class was divided into two to four groups, each spending at least 15 minutes on two to four different activities, one of which involved the computer. This was broadly the case in six of the nine observations.
- b) In Bill's class, where there were only two students, the whole class was able to move together from the board to the computer.
- c) During Mark's first observation, where there were four students and two computers, the students were able to spend the entire session working on the computer in pairs.
- d) During Mark's second observation where there were 21 students and 15 computers, the students organised sharing the computer facilities depending on which stage they had reached in the construction of their models.

Some relationship was evident between the teachers' philosophies of teaching and learning, and their classroom dynamics. For example, the most teacher-centred teacher, Bill, organised his class in a very teacher-led fashion, and the most student-centred teacher, Mark, organised his class in a very student-led fashion, as can be seen in the next section.

9.4 Analysis within the Brown and McIntyre (1993) framework

The transcripts of the follow-up sessions were analysed using the Brown and McIntyre (1993) framework. The methodology that Brown and McIntyre (1993) used to develop the framework was described in Section 5.3 and the framework itself was outlined in Section 3.2.2. The first part of this section briefly reviews the main features of the framework, and the remainder describes the findings of the analysis.

9.4.1 Overview of the framework

In their framework, Brown and McIntyre (1993) suggest that teachers evaluate their teaching by reference to two short term goals. The first involves setting up and maintaining *Normal Desirable States of Pupil Activity* (NDSs), which are steady states of activity which the teacher sees as appropriate for specific stages in the class. The second involves achieving pupils' *Progress* in terms of coverage of work, the creation of products and cognitive or affective learning or development. Brown and McIntyre (1993) found that the teachers they studied talked about their own *Actions* largely in terms of achieving these goals. The teachers also talked extensively about a number of *Conditions* which impinged on their teaching and influenced not only their actions, but also the standards they expected within the NDS and types of Progress. These conditions related to the lesson content, the material conditions, the characteristics of the teachers, and, the condition referred to most extensively, pupils' characteristics. Brown and McIntyre (1993) suggest that the four main concepts making up their framework interact as was shown in Figure 3.1; this is reproduced here for clarity.

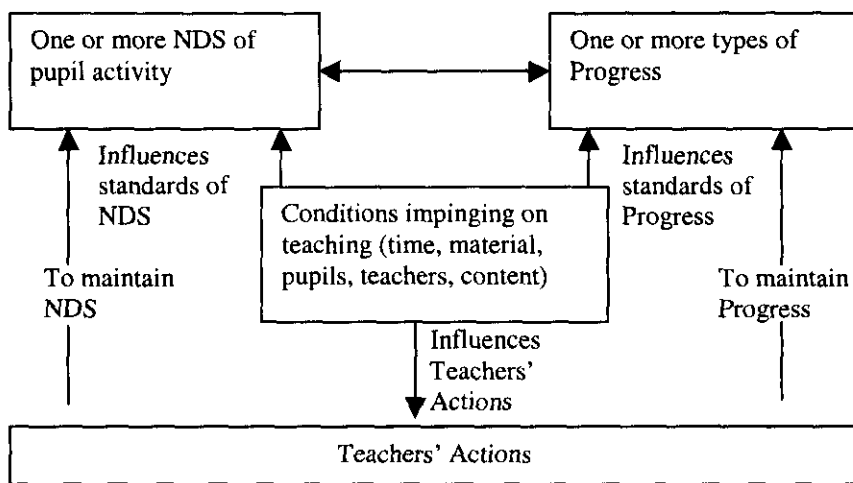


Figure 3.1 Interaction of concepts relating to classroom practice

(Brown and McIntyre, 1993, p.70)

The analysis described in this chapter relied on the above framework, but it was none-the-less approached with some caution bearing in mind the following points.

- a) The framework was developed in schools rather than FE.
- b) Brown and McIntyre's study participants were all experienced and "good"¹ teachers. In this study it was not possible to apply the former criterion unanimously, or assess the latter.
- c) Brown and McIntyre focused very deliberately on the positive aspects of their participants' teaching, whereas in the thesis observations the participants were encouraged to identify both positive and negative experiences in their use of CAL in the classroom.
- d) The thesis observations were limited to six teachers, and the time scale only allowed for one or two observations with each of these six.

¹ Much of Brown and McIntyre's (1993) account was concerned with how these "good" teachers were identified. This was done primarily through nominations by students and other members of staff.

e) The thesis observations relied on videotape, rather than audiotape, in order to stimulate recall during the interviews; this was because it was not thought possible to ask the teachers for the commitment involved in reviewing audiotapes in their own time (see Section 5.5.3). This meant that the researcher and teacher reviewed the whole of the hour session together, whereas Brown, McIntyre and their participants, were able to focus on key occurrences within the session.

The next section outlines the general themes evident in the way in which the teachers talked about their sessions. This is followed by two sections examining, firstly, Conditions and, secondly, Progress and NDS.

9.4.2 General themes

Brown and McIntyre (1993) discussed some common themes which emerged from their participants' accounts, such as *achieving student engagement and managing discipline*. Student engagement was also a preoccupation in the nine observations described in this chapter, but discipline issues were rarely mentioned. Such issues do feature in FE, but are less common in the relatively adult classes (particularly Access and A-level) which made up most of the observations.

The four main concepts which made up the Brown and McIntyre (1993) framework, NDS, Progress, Conditions and Teachers Actions, accounted for large sections of the thesis observation transcripts. However, there are three points worth mentioning here.

The first is that Teachers Actions seemed far less frequently represented in the FE teachers' accounts than in the Brown and McIntyre (1993) accounts. This could relate to the different occurrence of groupwork in the two. Brown and McIntyre (1993) stressed that, for the most part, their participants concentrated on how their pupils worked within either a whole class context, or as individuals; true group work, they

noted, was rare. The same could not be said of the observations described here. Only two of the nine classes did not feature collaborative group work, and whole class work was comparatively rare. Under these circumstances Teachers Actions would be likely to be less central to the functioning of the class.

The different occurrence of collaborative group work in the two studies may have been because of resourcing constraints. In the observations described here most of the teachers had access to just one computer, therefore their students had to work together. However, it emerged that such collaborations were a regular feature of these participants' classes. This may have been because the teachers were working with mature individuals on very intensive courses where co-student support was seen as highly desirable.

The second point is that there appeared to be a lesser degree of teacher flexibility in the accounts described here than in Brown and McIntyre's (1993) accounts. It may be that this related both to the need to cover large syllabuses in a short time, and also to the more frequent occurrence of groupwork in the FE group. Cooper and McIntyre's (1996) study on the implementation of the National Curriculum found that where there was a high level of factual content to cover, the teachers were less able to engage in reactive teaching. They also found that when the teachers had extensively pre-planned the lessons they

"tended to be less willing to depart from their planned lesson contents than those whose planning was less detailed" (Cooper and McIntyre, 1996, p. 130).

The rotating group work and computer integration described in this chapter were likely to have required such pre-planning. Additionally, when students are working on a number of structured activities it would seem much more difficult for a teacher to respond to and alter specific features of the session than it would do if the class was working as a single group.

The third point is to reiterate that there was one case where the framework did not seem to apply. This involved Jim who had only one year's teaching experience, and who was using a group-based classroom set up which was entirely new to him (as described in Section 6.6.2). Brown and McIntyre (1993) stressed that their framework aimed to explain how *experienced* teachers organised their thoughts about their *usual* classroom practices. Analysis of Jim's comments on his class provided a nice illustration of the boundaries of the framework, because, although the class ran beautifully, Jim did not talk about it in a way which reflected the framework's structural links. His account has therefore not been included in the remainder of this analysis. As noted previously, it was hoped that it would be possible to observe Jim a year after his first observation, but unfortunately this was not so.

9.4.3 *Conditions*

Brown and McIntyre (1993) said that their sample group talked about their classes with

"a richness of diversity which engendered in us both a warm feeling about variety in classrooms and also a mild terror about the task of achieving a coherent analysis of this collection of data." (Brown and McIntyre, 1993, p. 39).

The way in which the six participants in the thesis observations talked about their classes also demonstrated a considerable variety. This was despite the fact that the classes themselves were far less variable than those in the Brown and McIntyre study, in that they all involved computers and biology, and students of roughly similar ages and levels. Some of the thesis participants spoke extensively about their students' characteristics, backgrounds and aspirations; others talked more about the activities they had set up; some concentrated heavily on the technical side of using computers; and one focused on the context within which his lessons operated.

The various themes which were included under *Conditions* dominated some accounts and were almost absent from others. Themes to do with students'

characteristics emerged, as in the Brown and McIntyre study, particularly strongly.

These addressed both short term characteristics, e.g.

“As you can see Bill hasn’t done as well as he was hoping to and he’s barely listening to me at all ... he must be wondering if all that work is worth it” (Pam)

and, more commonly, long term characteristics, e.g.

“They’re lovely. They’re all nice, and as a whole group they’re great” (Maria).

Issues about timing were also commonly addressed, but these tended to be less about the time of the day or week, e.g.

“I was quite pleased with [the way] most of the chat was about the study, because this is a bit of a graveyard shift ... they never work as well in this lesson as they do in the morning lessons” (Maria)

and more about the time of the year, or the time available in the class, e.g.

“The biggest problem is this time management ... through the year ... I put pressure on them that they really didn’t need to have, because they’ve got to try and get this finished before the end of the year.” (Mark)

“I think they would have probably had ... slightly more time ... to look at the computer program ... had they done ... a bit of work at home ... and been more prepared for it.” (Andrew).

Issues to do with content, e.g.

“[Teaching students how to use graticules is] always a nightmare” (Pam)

were less commonly addressed and it was relatively rare for the teachers to comment (as Brown and McIntyre’s (1993) study participants appeared to do) on whether the content was easy or difficult, or required specific structuring of activities. However, several of the interviewees spoke extensively about the content in a less analytical fashion, e.g.

“I was just drawing up some very attractive chromosome on the board ... I’ve just drawn up a homologous pair of chromosomes and I’m going to explain what the chiasma are” (Andrew).

It seems likely that this extensive commentary on the context was because, unlike in the Brown and McIntyre study, both the researcher and the teacher reviewed the whole of

the observation, including parts about which the teacher had little to say. Therefore in these parts they appeared to simply give a description of what was happening.

However, it could also be that the teachers felt they did not need to expand on content-related issues because they were being interviewed by another experienced biology teacher.

Material issues, e.g.

"[Another class] just took apart all the pre-packed kits ... It was chaos. [Sharing resources] is the biggest problem about co-ordinating" (Mark)

were also relatively uncommon in the transcripts. This absence of focus on material conditions was also evident in the Second Interviews (see Section 8.3.2). In both cases it was surprising, particularly considering how extensively the teachers had written about under-resourcing in their survey responses. Brown and McIntyre (1993), however, found a similar situation in their study and suggested:

"The reason for this ... may be that by the time the teacher reaches the classroom, he or she has already become resigned to making the best of what is available." (p. 78).

Maria, who taught on two sites, provided a nice illustration of this dichotomy. In order to use the computer on one site she had to get it there by herself from the other site, but she did not mention this to the researcher until she asked for a help in moving the computer right at the end of the session, and noted:

"I have to take [the computer] back into college in the morning and I have to leave it in the car overnight, you can see why I don't rush to do this [session] too often! ... I can manage to do it [towards the end of the summer term] because the teaching timetable is fairly light ... otherwise it's a bit difficult." (Maria).

The final condition involved teachers themselves, e.g.

"I feel slightly uneasy introducing students to [the Internet] when I can't [really] use it myself." (Pam)

"This is where I was getting fed up with [the students]." (Andrew).

As with the previous two conditions, this rarely featured in the teachers' accounts.

What emerged strongly in several accounts, however, was a focus on the technical or procedural issues surrounding the use of the computer, or associated equipment. This was particularly evident when these procedures were complex. The technical focus did not fit particularly well into the Conditions mentioned previously, although there was some degree of overlap with material conditions and content. It may well be that a technical aspect needs to be incorporated into the framework as a separate Condition. What also emerged was a shifting in the focus of the Conditions in teachers who were observed over two sessions. This was particularly evident when they were using very different software in each session. For example, Pam had a very strong focus on student characteristics in both her observations. However, in her second observation material conditions, time and content became far more prominent than they had been in her first. These shifts in Conditions are addressed in more detail in the next section.

9.4.4 NDS and Progress

The main focus of the analysis was on the NDSs evident in the accounts. As with the pilot study, the aim was to see how far it was possible to explain the teachers' overall experience of using software in the classrooms with reference to the degree of conflict or agreement between the teachers' NDSs and the NDSs implicit in the program. Again, the way in which the teachers talked about their interpretation of the program gave a good sense of this (see Section 6.6.2).

The overall idea was that if mismatched NDSs could explain teachers' problems in incorporating software, then it should be possible to see some evidence of NDS agreement where the teachers felt happy about the program's use. In practice this proved to be largely the case. Of the eight observations (i.e. not including Jim's) there were only two (both with Pam) where the teacher expressed clear reservations about their implementation of the software; in both cases there was evidence of conflicting

NDSs, although, in one the teacher's dissatisfaction did not appear to be tied tightly to the NDS conflict.

In the other six cases, three showed clear NDS agreement, and three were more problematic for reasons discussed later. What became apparent was that it was possible to distinguish the conflicting NDSs (in both Pam's cases) and the agreeing NDSs (in Maria, Bill and one of Andrew's cases) in sessions where the computer activity was relatively constrained, in that it was used for a limited time and was not absolutely central to the class. Where the computer activity was pivotal, it was far more difficult to distinguish NDSs. The following three sections illustrate this with reference to

- a) the three cases where the NDSs agree
- b) the two cases where the NDSs conflict
- c) the three more difficult cases.

a) NDS agreement

This was evident in Maria and Bill's observations, and Andrew's first observation. This section aims to describe some of the main features of each of these three observations in order to illustrate the agreement.

Andrew 1

Andrew's first observation was described in full in the pilot study (see Section 6.6.2), but the main features are summarised here to allow comparisons to be drawn. Andrew was running a session on cell division, using the *Mitosis and Meiosis* tutorial program from the Second Interviews. This was the first time he had used the program in his teaching. He had set up three different activities and the students were working in three groups, spending approximately 20 minutes on each activity.

One of the activities, which he often used, involved the students working with bioviewers (modified microscopes) and looking at microscopic photographs showing the different stages of cell division. Bioviewers are accompanied by explanatory texts, which refer to each photograph and are interspersed with questions. Andrew's aim was that the students should examine the photographs and read through the text to reinforce material they had already covered. While doing this they should be answering the bioviewer questions while referring to him or other group members if there were any problems. The activity therefore gave them a chance

“to look at the stages of [cell division] as they really appear [and to] pick up additional information ... Or [the text can] help their understanding ... [And] it gives them an opportunity to ask questions as well.”

The computer activity was very similar. *Mitosis and Meiosis* is a short tutorial program with animations of cell division, accompanied by explanatory text and questions. Andrew wanted the students to look at the animations

“and then go through and read each section. There were some questions on it which weren't working properly. But ideally that's what I'd have liked them to have done, gone through it, self testing as a group ... They've seen [cell division] as diagrams of different sections, but [the computer is] giving them a view of it as a continuous process.”

Both activities therefore shared the same features and involved the students working in the same ways, i.e. looking at different representations of cell division, reading through associated text, answering questions and checking their understanding of previously covered material with both the teacher and each other. In this way there was agreement between what emerged as one of Andrew's usual NDSs and the NDS of the computer program, and his overall summary of the class was that the activities

“worked OK [and] all slotted together to give a much broader and a much more realistic view of cell division”.

Maria

A similar coherence was evident in Maria's session. This was the final class on ecology with a group of A-level students. During the previous week they had recorded the animals present in a local river to assess the pollution level. During the observed session Maria wanted the students to interpret their results and produce a written account of the investigation. Interpreting the results involved using a data analysis program (*Ecosoft*). Data was entered into the program, which then displayed a pollution scale (ranging from unpolluted to highly polluted) with a number on the scale highlighted to reveal the results of the analysis. Maria noted that the program

“gives [the students] an instant result, cuts out the unnecessary number crunching and they understand exactly what the result means”.

Maria brought the whole class together for several short periods during the observed session to ensure that the students knew exactly what they had to do, and to collate group results or ideas. The session was more Progress oriented than Andrew's, and was broken up into short stages, the intermediate products of which (i.e. the methods, results, discussion and evaluation) could be combined to produce a final product (i.e. the overall account).

During most of the session the students worked in groups of three to five which Maria had organised

“to mix the class up a little bit [and] to bounce ideas off each other”.

Her intention was that the groups should be working very much “to task” but in a relatively informal and enjoyable fashion such that

“a little chatting is allowable as long as the majority of time is spent on this.”

The students accessed the data analysis program for short periods, in pairs during the first half of the session. Maria showed each pair how to enter their data and returned at various points to make sure there were no problems. She noted:

“Generally speaking they get the hang of it pretty quickly and I can disappear ... I want them to have the fun of doing this”.

Maria’s general NDS appeared to be that the students should all know exactly what they were meant to be doing, and that they should work in groups in a collaborative, focused, but enjoyable fashion, to produce end products to which they had all contributed, and about which they had no uncertainty. The computer activity fitted very well with this, and Maria noted:

“I like the nice visual effects ... [when I first used it] I was really impressed when up popped the scale with the pollution level all there and I thought - this is what we want at the end of an experiment, we want the students to go away and say ‘this is what I learnt from this experiment’ instead of this very woolly idea that is sometimes taken away”.

Overall there appeared to be agreement between the NDSs, and Maria concluded:

“I’m quite pleased with the way it went today. I’ve done it worse! I felt that [the students] were gainfully employed throughout the lesson. I felt from going around the groups that they have got what I wanted from it, that they had understood why they had done the sampling at the river ground and why they were putting the results into the computer”.

Bill

The NDS agreement was not so straightforward in Bill’s case. Here it became clear that he perceived the NDS of the program to be at odds with his own, but was able to modify the program’s use so that it fitted in.

Bill’s session provided an introduction to the heart. This was a very small A-level class, with only two students, and Bill was using a CD-ROM on the heart which he had used before on a number of occasions. Most of the class consisted of the two students taking notes or filling in handouts while Bill went through aspects of heart structure and action using board work, transparencies, charts and dissection specimens. He stressed that the students were less active than he would have liked, but noted:

“when you’ve got a very small class it’s difficult in terms of how many questions you can ask them, because they’re out in the open ... so I’m basically talking the full 45 minutes.”

Bill had a strong focus on providing variety in terms of different visual representations, and this was something which had also emerged during the Second Interviews. His general NDS involved the students working singly and focusing strongly on the different representations he was using to deliver theory:

“I do enjoy drawing on board and they can see how to construct it by watching me. So [this student] is following my arrows and putting his arrows in, and basically is not doing anything else except concentrating on the heart. Hopefully he is learning it as he’s doing it ... I wouldn’t leave out the chalk and talk completely as it’s probably still the best way to learn things, because the students can’t do anything else, if you’ve got their concentration they must be learning something from it.”

During the last 15 minutes of the class Bill and the two students moved to the computer. The CD-ROM consisted of extensive text plus a number of animations and a quiz. Bill moved rapidly through the text pages, concentrating on the animations, which he used in order to back-up the theory they had already covered. He stressed the need to modify the program:

“I used three sections of the bits of software that I knew had the animations, and I left out most of it which was just reading text ... I think it needs a teacher as well, it needs someone to take them through it ... I would rather have no text, just animation and the odd labels because I think that’s more an adaptable tool that you can use. You can say things and bring in the other bits of the lesson, whereas if it stands alone with its text it’s difficult to blend in [and] sitting around a computer reading text is a bit boring, isn’t it?”

Most of the computer session was spent on the quiz, which showed three aspects of the cardiac cycle, only two of which were in phase. The user’s task was to identify which one was out of phase. As before, this session involved students focusing on Bill’s presentation and explanation of another visual representation, although he noted:

“Again I’m taking control here, there’s no reason why they couldn’t have done that on their own ... [Although] they seemed quite happy with me pushing the buttons”.

Overall the modified computer activity seemed to fit very well with Bill’s general NDSs and he was pleased with the overall effect, commenting:

“It’s just brings it altogether in an animated way, the interactivity of it; by pressing a key you’ve got control of stopping or starting the sequence. It’s got both of them concentrating on it and then not thinking of anything else and they’re learning about the heart. I felt that the three of us were ... not mesmerised, but sharing something together really, which was nice.”

b) NDS conflict

There were two cases in which NDS conflict was evident; both of these involved Pam. As with Andrew, Pam’s first observation was described in full in the pilot study (see Section 6.6.2), but the main features are summarised here to allow comparisons to be drawn.

Pam 1

In her first observed session Pam was teaching a second year A-level class on movement. Pam’s account had a very strong focus on student characteristics, and this was reflected in her NDSs and a number of affective Progress goals. She had organised four different activities, which the students rotated to while working in four collaborative groups. One of these involved using the *How Animals Move* CD-ROM from the Second Interviews, which Pam was using for the first time. The other three activities involved a theory session with the teacher on muscle structure and action, a short practical on muscle fibre contraction, and an exercise where the students had to use a model of a human skeleton to answer questions on a worksheet. In this account the skeleton exercise will be used to illustrate Pam’s typical NDS.

The students were working in a collaborative group of four, looking at and moving the skeleton, comparing its movements with their own, and drawing in previously covered theory to label diagrams and answer a series of questions on the worksheet Pam given them. She explained:

“it’s not a look-at-it-and-name-it exercise, it’s a think-about-it exercise ... I wanted them to actually interact with that skeleton, I want them to know all the bones, feel the bones, see the bones, know where holes are, think about the significance.. I know it works, and I know they learn well from it ... So at the end of the lesson everybody had completed the skeleton and felt confident they could answer a question on it ... So I felt good about the skeleton, they felt good about the skeleton”.

At one stage Pam noted about the group working with the skeleton:

“noisy, isn’t it! . . . But they were enjoying themselves ... I prefer noisy committed students than silent.”

Pam’s NDS emerged quite clearly in the way she talked about the class. It involved the students working to a definite pace through a structured activity, being highly focused and engaged, interacting both intellectually with each other and her, and physically with the skeleton, enjoying themselves and feeling competent and confident about their grasp of the material; the other three activities all revealed similar goals.

The computer activity was the only one in which the students were not following a clear sequence which involved them thinking about specific questions, discussing the answers with their colleagues and working at a definite pace. Pam intended that when working with the computer the students should be looking at the animations and video of muscle action and insect movement, checking what they were seeing against theory they had already covered and generally exploring the material in the CD-ROM. Pam’s perception of the NDS of the program was that it was designed to let the user explore at their own pace, and although she was very enthusiastic about the visual quality, she felt that it had failed to engage the students:

“Maybe they thought that it was an unimportant activity, do you know what I mean? It wasn’t the experiment, it wasn’t the skeleton - although the skeleton they were interacting with quite beautifully, and nobody was prompting them with the skeleton. But when they were working with the computer, I don’t know, maybe (pause) there would need to be questions on it to make them interact, and that is actually against the whole spirit of the CD-ROM, isn’t it? So, you know, difficult, very difficult. I’d be interested to see how somebody else uses it”.

The mismatch in NDSs emerged very clearly in this account. However, Pam still expressed her intention of using the program again in a modified form so that it was better matched to her goals. Bill was the only other teacher who showed such modification during the observations.

During the Second Interviews it was suggested that the programs from the software pool might be fairly amenable to modifications which allowed them to be incorporated into a teacher’s usual classroom structure (Section 8.7). Following the analysis of the observations it seemed as though this was in fact the case, and that the programs mentioned so far (i.e. fairly compact tutorials, CD-ROMs and small data analysis programs) could be modified fairly easily. This did not appear to be the case with larger applications such as experimental interfacing, programming and the Internet, as the next few interactions show.

Pam 2

Pam’s second observation took place nine months later and involved a computer exercise she had used before. During the second session she was working with an Access group which was generally less confident than the previous second year A-level group. She had set up a number of activities which focused generally on developing practical, rather than conceptual, skills. She still focused on student confidence, enjoyment, and interaction with the teacher and each other, but this account had more of a stress on Progress than was evident in her previous account. The skills she was

working on involved producing drawings of plant cells, making microscopic measurements using graticules, and using the Internet to access information on smoking and health for an assessed essay. In this chapter the Internet exercise will be described and compared with the graticule exercise.

Pam had divided the class into three groups. Her intention was that each group should spend about 30 minutes on the Internet. As in her first observation, Pam aimed that the students should work collaboratively, to a defined time limit and with a clear end goal, in this case a print out of information sources. However, as with the previous use of the CD-ROM, this activity was relatively unstructured. What was particularly noticeable was that Pam did not talk about the activity in terms of the NDS, other than to comment, briefly, on the group work, e.g.

“You heard me very definitely say I wanted it shared, because I do want them collaborating with each other rather than competing ... the second group were using [the first group] for information so it was a cumulative thing and they were working together very nicely.”

Instead she seemed to rely primarily on Progress criteria in both outlining why she set the activity up, e.g.

“ [so that the students] come away with the impression that ... it’s going to be a useful toy ... I’m really using this as a way of teaching students about the possibilities. I’m not selling it, I’m just putting it in front of them and saying - *there’s an opportunity*”,

and in evaluating it, e.g.

“I was keeping an eye on what they were doing, if I saw a lull I would come across. ... I still can’t see anything printing out. I’m aware that their time is coming to an end and they’ve not got much in their hand, that’s a negative experience because they’ve spent quite a long time, longer than I intended, and it was going nowhere.”

Time issues featured more strongly in this account than in Pam’s first account, as did comments about the technical difficulties which had emerged for both her and the students, e.g.

“They keep telling me that they can’t get onto the Net over [in the library]. I double checked that with the computer technicians who put in some of their numbers and assured me that they were in fact in. They’ve not been on but they’ve got access so they’re obviously not doing something correct”

“[The college] system seems to crash on me every time. Friday afternoon it went down 3 times in an hour and so that’s a total waste of my time.”

There were strong similarities between the Internet exercise and the graticule exercise. Graticules enable the user to make microscopic measurements, and because this involves using microscopes, graticule exercises are essentially solitary. Pam’s students were therefore simply working to an end point (i.e. of coming up with a measurement for the cells they were looking at) and consulting her when they came across difficulties. To a large extent it seemed as though there was no other way of carrying out this activity effectively, and therefore graticule use appeared to dictate its own NDS. As this NDS involved students working alone on a relatively unstructured activity, it was at odds with the other NDSs which had so far emerged from Pam’s observations. However this aspect received little comment as, once again, Pam’s focus was primarily on Progress issues, both in terms of setting the activity up, e.g.

“I do think it is important to ... go through that whole business of using a graticule stage micrometer which is nightmaresville. We can take time here and it gives them a sense of confidence when they go on [to University]”

and in her evaluation of it, e.g.

“Half the class now know how to use a graticule and micrometer. The ones who were going to get it easily now know how to do it. The ones who don’t, haven’t got it, and maybe are even more lacking in confidence that they’re ever going to get it.”

Technical difficulties also emerged here, as they did with the Internet exercise, e.g.

“Elaine’s got real problems with the graticule. She’s done her recording, she’s worked out how many eye piece units are equal to the stage micrometer and now she’s confused about how to convert her eye piece units into real measurements. The trouble was that we were eventually working at cross purposes because she was using 10 eye piece units and I was working along with what I conventionally use as 1 eye piece unit. It took us a

while to sort out that misunderstanding ... [it's difficult] having to try and discuss it down a microscope."

Comparison of Pam's first and second accounts revealed a definite shift from a focus on NDS to a focus on Progress. It is possible that Progress goals only feature strongly in teachers' accounts when they are not met, and therefore such goals featured more prominently in Pam's second account because she was not particularly satisfied with the outcome of the activities she had set up during the second observation.

However, it was also clear that Pam saw both the graticule exercise and the Internet exercise as inherently important, rather than as pedagogical vehicles. Therefore it seemed as though these activities were Progress goals in their own right. The suggestion here is that when a classroom activity

- is an important Progress goal
- is technically quite difficult
- *effectively dictates the mode of use (i.e. the NDS)*

then the teachers focus more on how to get to the end point and less on NDSs. This pattern became even more marked in the final three observations. Before moving on it is worth noting that Pam's observation provided a useful reminder that implementation problems do not just occur with innovations but can also occur with well established procedures.

c) Three more difficult cases

The final three cases involved Andrew's second observations and both of Mark's.

These shared some significant features; namely that the follow-up sessions all involved a focus on Progress, material conditions and technical aspects, and that the classroom sessions were characterised by the centrality of the activity in which the computer was an essential part.

Mark 2

As noted earlier, Mark's second observation was unusual in the context of the nine observations, being part of an "enrichment programme" he ran on control technology. These programmes were designed to supplement more standard science A-levels.

In terms of the NDS, Mark required that the students worked either singly or together in a strongly self-motivated fashion, organising their own activities, keeping pace with the rest of the class and referring to him to check their work:

"You've got to be quite precise and it's quite satisfying because if it doesn't work it's your fault and they realise that [it doesn't work] because they didn't do something or they assumed it would do something ... If the majority of them have built their models, it's those who are less keen that haven't built them and therefore I have virtually moved on to the next stage which is the programming. There's less time with those who have been less keen and are further behind".

Although this NDS was fairly clear, there were no other NDSs to compare it with and therefore there was no indication of whether it fitted in with Mark's general practice; this illustrates one of the limitations of the size of the study.

However, despite the clear NDS, what emerged most strongly from the follow-up session was Mark's focus on the mechanics of getting to the end points of the course. These end points involved the students designing, building and programming models, which ranged from conveyer belts to flying birds. This focus on Progress goals was shown, for example, in his answer to the following question:

Were there parts of the class which you thought were particularly successful?

"Some of them yes. [Over] the last few weeks there have been some very impressive ones where [for example, one student produced a] conveyor belt, he loaded it up with little bricks and he's got a track with 3 carriages and he can load 3 bricks into each carriage."

Mark's focus on Progress encompassed a number of technical aspects, e.g.

“Trying to get 2 gears to work together is really quite difficult because they have to mesh together or you use a chain drive between them and you’ve got to get your distances right. The motors are not that powerful and if the shaft is not square it puts too much pressure on the thing and the whole thing jams”.

It was also strongly affected by several Conditions. These included:

- material conditions

“Half of the problem with this is the organisation of space”

- time

“It got too rushed at the end - we should have finished it by now and we haven’t and it’s now after their examinations, their 1st year external examinations. We spent too long planning it. When we first started this we were over in B block up in a room, we only moved over to there half term so we lost the first six weeks - it was very disorganised”

- student characteristics

“There’s a lot of personal responsibility in terms of ... once they’ve decided what they want to do just getting on with it and thinking about how it’s going to happen. A lot of them it’s pretty obvious that they think about it during the week because when they come in they’re really enthusiastic. [They are] the people who [identify and] enjoy trying to solve that problem”.

Andrew 2

Andrew’s second observation involved what was, for him, not a standard class. He had been off sick for several months and was running a session for a colleague with a group he did not know well. This session involved a demonstration of the use of a spirometer to show the effect of exercise on oxygen consumption, and breathing rate and depth.

Andrew had used the equipment several times before but was linking it to a computer for the first time. The group consisted of 18 Access students who were two weeks from the end of the course and coming up to their final exams. Andrew divided the group into two; most carried on with their revision and four helped him set up the demonstration.

Two main points emerged from Andrew's observation. The first was that because the session was not the norm, much of his follow-up session focused on this, and consisted of descriptions about how the sessions would usually be run, e.g.

"Ordinarily it would have probably been earlier in the year and it would have been linked in with an assignment. I would have done an assignment and ... got the students to do another task which they could do more independently while the group's working on this, and then run it over, say, two sessions ... In the past what I've got students to do is to work through and make notes on breathing, respiration, and to use a CD-ROM package in small groups".

These descriptions were generally coupled with focus on the timing and access to equipment required to make such sessions successful. Therefore, as in Mark's second observation account, these two Conditions emerged as being important. However, by comparison with Mark's account there was very little focus on the students; possibly because Andrew did not know them well, but possibly because of the technical focus outlined below.

The second main point concerns the NDS. There were two major activities happening in the class, and so the aim of the analysis was to explore the NDSs for each. A generalised NDS was evident in the way Andrew talked of the activities for the main group of students; he intended that at the start of the class they should listen to his brief introduction to the spirometer, so that they got "an overview of the equipment and how to use it". Following this he wanted them to work in a largely independent fashion, and be "all hard at work" while answering questions on last year's exam paper, either singly or in groups, as part of their revision programme. At intervals they should come up, whenever convenient, to watch the demonstration.

The other group consisted of four students who had volunteered to assist with the set up of the spirometer, so that there was

“someone for cycling, controlling the computer, monitoring the oxygen and someone for watching the subject”.

What was noticeable during the analysis of the way Andrew talked about this activity was that it was impossible to identify any NDS. Andrew’s focus was instead very much on the mechanics of setting up and running the spirometer. In this way his account was similar to Mark’s, with its concentration on Progress. Andrew’s account also showed, as did Mark’s, a focus on technical aspects, but here the procedure itself appeared more exacting, and Andrew had to concentrate on a number of aspects. These included:

- setting up the equipment

“You have to be careful which way you set [the sensor] up, it’s actually pointing backwards, otherwise it goes in the wrong direction”

- calibrating

“We’re going through the calibration which is the most complicated bit”

- running the equipment

“It’s quite a difficult thing to explain to students anyway because there’s lots of things going on, like refilling the oxygen”

- monitoring health and safety

“[You need] to keep an eye on the subject to check that they’re happy breathing oxygen with the spirometer [also] to check that they’re disinfecting things.”

What seemed to have happened here was that the spirometer’s operation was exacting enough to dictate the NDS of the students, which was that they should follow a detailed set of instructions. Andrew’s focus was primarily on how to manage the complex technical task of getting to the Progress goal (i.e. setting up the spirometer), and under these circumstances it appeared that he ceased to focus on his own NDSs as a primary organisational goal, because following the spirometer’s NDS was the best way of getting to the Progress goal.

Mark 1

A very similar pattern was revealed in Mark's first observation. Mark taught a group of 22 GNVQ students who were, at the time of the observation, working on an assignment which centred on the production and analysis of data showing how exercise affects heart rate. This involved using exercise bikes linked to computerised cardiac monitors.

However, because the data production was time consuming, and therefore detracted from the more important learning goals involved in data analysis, and because Mark could only get access to two computers, the actual data gathering part of the assignment was run outside normal class time, with the students coming to the laboratories two pairs at a time, and with Mark supervising the procedure. Mark stressed the need for extensive teacher involvement here:

“Although you tell the students how to do it, they don't really understand all the fine details so you're almost compelled ... to get a result, to be with them, work with them and help them and put the emphasis more on how they interpret the results rather than actually collecting the data”.

In *whole class* terms it therefore appeared that the activity's NDS, which involved students working at the computer for at least 30 minutes, following precise instructions and having almost continuous teacher support, was not compatible with Mark's NDSs for a group of 22 students, and was not sufficiently linked to the Progress he was looking for (which involved analysis of the data) for him to give valuable class time to it. The observation therefore involved a “sub-class” of four which revolved around the computer activity.

So, as with Andrew's class, Mark's sub-class was taking place under relatively unusual conditions, and his account revealed a similar focus on this, accompanied by a similar stress on material conditions, time, and possible alternative ways of managing in future:

“[If] we could have a whole room full of exercise bikes and computers and monitor everybody up, then yeah [having more than two groups] would be possible ... with technical support.”

“We can’t really give them this much attention [in future], this is just voluntary stuff - we can’t afford to do it”.

When reviewing the sub-class Mark stressed that:

“[Computers] are tools to be used and they’re not the end in themselves. The aim is not to be able to use the computer, the aim is to be able to collect the data that they can analyse and that’s a big conceptual leap.”

However, the short-term Progress goal, (i.e. producing the print-out), involved extensive use of the computer, and, once again, the procedure was complex enough to dictate the students’ actions and require that they followed precise instructions:

“All that preliminary stuff was setting equipment up, making sure that the heart monitor was on, the ear clip strapped on and everything plugged in correctly. Then there comes a time when if they want to compare the 2 sets of data it has to be synchronised. They need to start both bits of equipment at the same time and in doing so they need to set the wrist watch monitor to start recording and at the same time make sure that the software on the computer is running. It is important to make sure that it is 1, 2, 3 GO otherwise they tend to be very casual about it.”

As with Andrew’s account there was almost no indication of an NDS during Mark’s observation, other than that students should follow instructions, and once again it seemed that the degree of complexity of the procedure allowed little room for manoeuvre, but that this was tolerated because it was so closely linked to the Progress goal.

Finally, as noted earlier, after the analysis of the observations was complete, a paper showing the findings was sent to four of the observed teachers with a request that they comment on how far the analysis matched their experience of using the software. Responses were received from Andrew, Maria and Mark. Andrew and Mark noted their general agreement with the analysis, although they did not comment specifically on

ideas of NDS and Progress. Maria also noted her general agreement, and further commented

“I did agree with your conclusion that my NDSs largely matched those of the *Ecosoft* program I was using. I think that the simplicity of the program and the fact that I have done that lesson at least 6 times before with A-level and Access students were important factors in the NDS agreement.”

9.5 Conclusions

These observations were able to provide more information about the features of software which teachers saw as being useful. During the Second Interviews the teachers talked about the programs from a *planning* perspective, that is, before they had used them. During the observation follow-up sessions the teachers talked about the programs from a *classroom practice* perspective, that is, about issues which arose while the programs were being used. It was noticeable that there was considerable overlap between the two perspectives, as follows.

In Section 8.7 it was suggested that teachers perceived software as useful if it matched their requirements in terms of interaction with users, information quality and classroom integration. These requirements appeared to be embedded in the NDSs of the teachers observed here. For example: Bill’s NDSs included considerations of student engagement; Pam’s NDSs included considerations of the quality of the information, particularly whether it was structured and challenging; Maria’s NDSs included considerations of the need for any procedures to be simple and quick, so that students could complete the exercise quickly, and by themselves, after minimal instruction, therefore allowing her to work with the rest of the group. In Section 8.7 it was also suggested that the software needed to match syllabus requirements for the teachers to see it as useful. This requirement appeared to be embedded in the Progress concerns of the teachers observed here. For example, the driving force behind Pam’s use of the

graticules, Andrew's use of the spirometer and Mark's use of the heart monitors was two-fold; on the one hand these were applications which would be useful to the students in their future studies, on the other hand these were activities which were specified in the syllabuses. The fifth criterion outlined in Section 8.7 was that software would be perceived as useful if it could overcome a specific pedagogical problem. Evidence from the Second Interviews and observations suggests that this criterion could fall under either the NDS or Progress depending on the specific context.

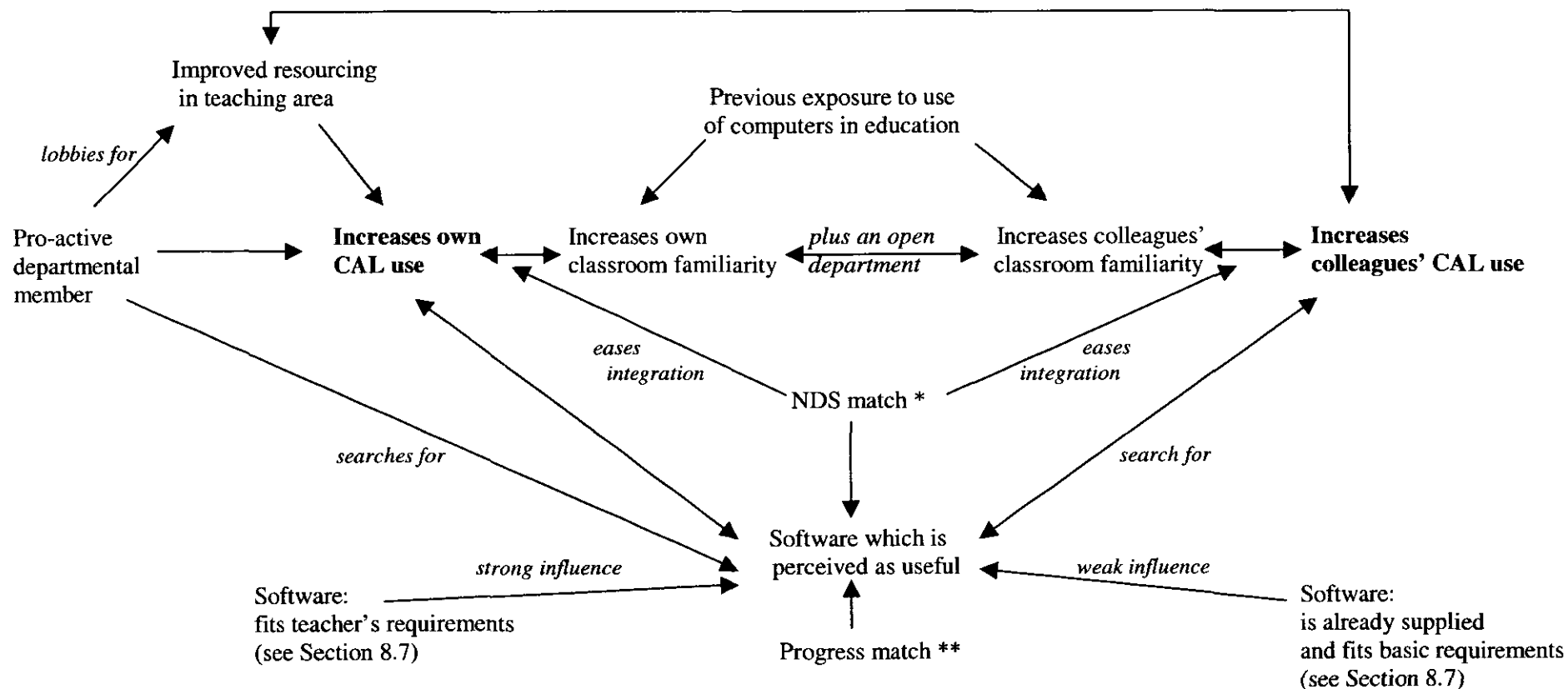
Many of the observation findings, however, could not be anticipated from the interviews, and the rest of this section addresses these findings.

It was noted in Section 9.4.1 that there were several concerns about the use of the Brown and McIntyre (1993) framework in analysing the observations; one of these was the fact that the framework had been specifically developed in schools. To some extent this concern was justified, and there were several key differences between the ways in which Brown and McIntyre's (1993) participants and the participants of the thesis observations organised and talked about their classes. Two of these differences were highlighted in Section 9.4.2; they concerned the fact that the FE teachers appeared to focus less on Teachers Actions and to demonstrate less flexibility in responding to changing classroom circumstances than Brown and McIntyre's (1993) teachers. It was suggested that these differences may have derived primarily from the fact that group work and intensive syllabuses featured heavily in the classes which were observed here.

Another difference between Brown and McIntyre's group and the thesis group centred on the fact that there was considerable talk about technical or procedural issues in the latter. This was not so in all of the accounts, and appeared to be directly related to the technical difficulty of the procedure being observed. However, it may be useful

to consider it as another Condition, and one which could greatly affect the type of NDS the teacher could aim for.

Overall, the NDS and Progress concepts seemed to provide very useful reference points to describe teachers' experiences of using CAL in classrooms. Considerations of NDS were particularly useful in the cases where the program was relatively constrained and not the main focus of the class. Under these circumstances it was possible to identify three cases (Andrew 1, Maria and Bill) where there was clear NDS agreement and the teacher was happy with the computer activity, and one case (Pam 1) in which there was clear NDS disagreement, and the teacher was not happy with the computer activity. Figure 9.1, overleaf, shows a modification of Figure 8.1 which includes considerations of NDS and Progress.



arrows show direction of influences

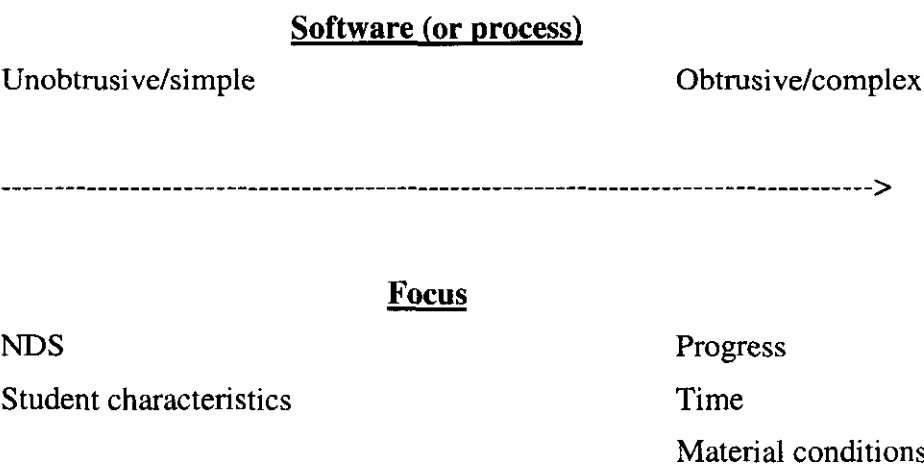
** includes considerations of information, interaction and classroom fit, and overcoming pedagogical problems*

*** includes considerations of syllabus fit, and overcoming pedagogical problems*

Figure 9.1 Grappling with the obstacle course: how classroom dynamics affect the picture

Where the situation became more problematic was where the computer activity was linked to a Progress goal. Here, in one case (Pam 2) there seemed to be a conflict between the Progress goal and the NDS goals. In this case the teacher appeared to focus on the Progress goal while still searching for ways in which to reconcile this with her NDS goals. It was also clear from this teacher’s account that such clashes featured in other activities which did not necessarily involve the computer and were not necessarily new to her.

The strong focus on Progress was even more evident in cases where the procedures were technically difficult and the computer activity was more pivotal to the session. The shift in focus from NDS to Progress was also accompanied by a shift in the focus within the Conditions, from considerations of students’ characteristics to considerations of the influence of material conditions and time. This is summarised as follows:



When the software was simple and unobtrusive (as it was with the CD-ROMs and data analysis program), then the teachers focused on their own NDSs and their students’ characteristics. When the software (or process) was more obtrusive and complex (as it was with the Internet, graticules, spirometer and heart monitor), then the teachers’ focus

shifted away from their NDSs, and the NDSs of the software (or process) became more dominant. Brown and McIntyre (1993) suggest that a teacher will find it very difficult to incorporate innovations into his or her classrooms if these innovations have NDSs which differ from their own. However, the differing NDSs were evident in at least four of the observations described in this chapter; in all four cases it was suggested that the teachers tolerated the shift away from their own NDSs when the activity which caused this shift was inextricably tied to a useful Progress goal.

Conclusions drawn from this chapter needed to be tempered by the fact that the number of observations was fairly small, and the individuals who were observed were all apparently enthusiastic about moving forward in their computer use. However, it appeared that when the computer application had a marked “perceived usefulness” the teachers were prepared to make considerable adjustments to their normal classroom practice in order to use it. The obvious conclusion from this is that the development of good biological software will provide great assistance to biology teachers in their journey through the obstacle course.

Evidence from both the interviews and the observations suggests that software needs to be designed so that it clearly fulfils syllabus requirements. McIntyre (1998) (see Appendix Eight) commented on the findings in this chapter as follows:

“One of the interesting things about [your observations] is that none of the reported cases seem to be about new approaches to pedagogy, or therefore new suggested NDSs, but are rather about new content-learning experiences, which the computers may be able to deliver for the students”.

It is suggested here that this may be because the observations were, on the whole, operating within the confines of rigorous, content-laden syllabuses. Again it is suggested that there is a need to consider how far such syllabuses impede any development of new pedagogical approaches that might be achieved using computers.

In many ways the findings from these observations reflect Cooper and McIntyre's (1996) findings (see Section 3.2.2), in that their study on the implementation of the National Curriculum found minimal "classroom resistance". However, Cooper and McIntyre also pointed out that the implementation of the National Curriculum was legally binding, resulting in schools responding to it on a corporate level. Such as response allowed for "collaborative planning and ... sharing of ideas" (p.160). This contrasts strongly with the observations described here, where the teachers appeared to be carrying out significant classroom experimentation in relative isolation. Once again, a major conclusion from this field work is that there is a great need for educational establishments to formally support teachers in collaborative enterprises. Again it is suggested that this might be best fostered by the introduction of staff development programmes which focus on collaboration.

Following Chapter Six it was noted that both resourcing and educational philosophies appeared to have close relationships with classroom dynamics. It was hoped that the observations would yield more information about this relationship; however, the way in which the field work was structured did not facilitate this. It is suggested that in order to study these factors, classroom observations may need to be coupled with analyses of the teacher's concerns while they are *planning* their sessions.

The research described here relied heavily on the Brown and McIntyre (1993) framework. McIntyre (1998) noted that in this research the framework had been used in ways neither he nor Brown had anticipated. He pointed out that they had not considered "the idea that each teacher has characteristic kinds of NDS" (see Appendix Eight). However, he noted that the observations described in this chapter indicated this might well be the case and that it might be possible to assess these kinds of NDS with a degree of objectivity. Further research is needed on the issue of objective identification of

characteristic NDSs, but the research here indicates that the NDS concept, and the Progress and Conditions concepts could provide a fruitful means of tracking teachers' experiences of incorporating innovations in the classroom.

Chapter Ten: Conclusions

This chapter outlines the achievements of the thesis. It summarises the main findings and their implications for staff development, policy decisions and software development. The chapter provides an assessment of the main limitations of the thesis, and outlines the potential for further research in this area. Chapter Ten is organised as follows:

Section 10.1 *Achievements of the thesis.*

Section 10.2 *Main findings of the thesis.*

Section 10.3 *Limitations of the thesis.*

Section 10.3 *Further research.*

10.1 Achievements of the thesis

The main aim of this thesis was to build a fuller picture of the relationship between teachers and educational technology in a relatively under-studied sector (FE) and within a specific subject area (biology). The further aims were that this picture should provide some key answers to the following questions:

1. Why do teachers make such little use of educational technology, and what conditions might particularly encourage or discourage teachers' use of CAL?
2. Which of these conditions could be addressed by those who decide on FE policy and staff development programmes, to help FE teachers make more use of educational technology?
3. Which aspects of CAL do teachers find most interesting and useful? Are these aspects which software developers can consider during the design process?

4. Which methodologies might be fruitful in future examinations of the relationship between teachers and educational technology?

The contributions of the thesis in answering these questions are described in Section 10.2.

Overall the contributions are as follows.

1. The thesis provides a review of literature on teachers and their use of educational technology in order to identify a range of factors for further investigation. The review included broad scale research based on surveys and in-depth research based on case studies. It also included key policy documents and expositions on the nature of educational establishments (and hence the nature of classroom practice). The factors which emerged from the literature review as having a major impact on teachers' use of CAL were represented pictorially as an obstacle course, shown below.

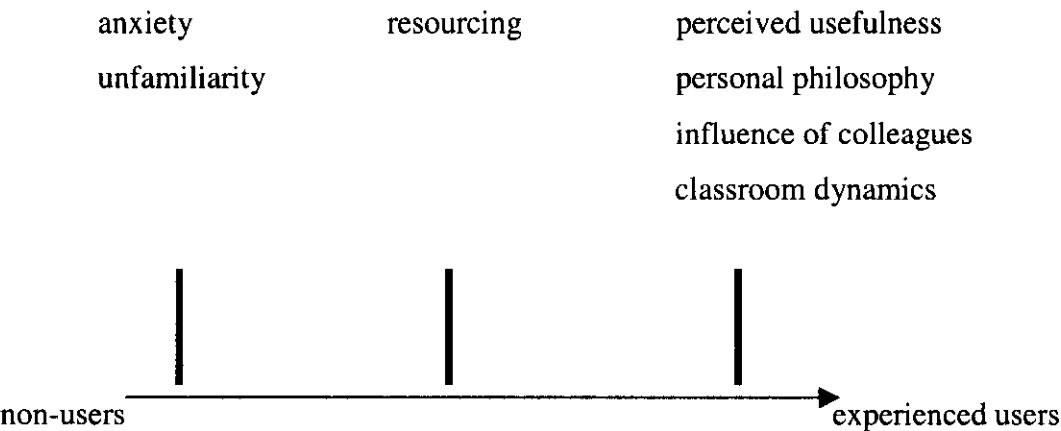


Figure 10.1a The obstacle course

It was stressed that the journey from non-user to experienced user was likely to be far more recursive than this pictorial representation implied. During the field work, further illumination of the factors on the obstacle course emphasised this recursiveness and

suggested that a more appropriate representation might be as follows:

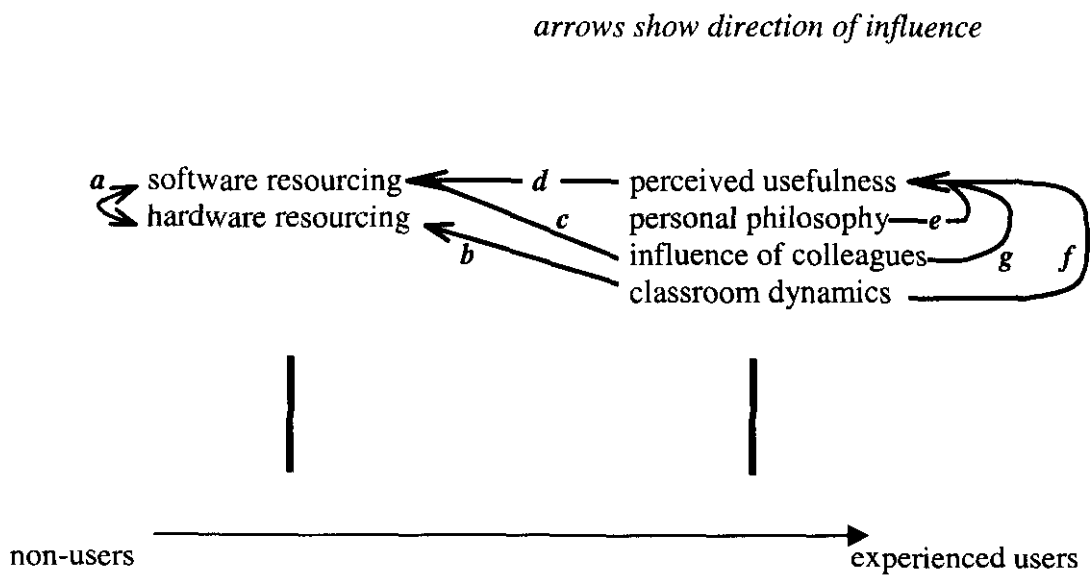


Figure 10.1b The modified obstacle course

Some of the links proposed in Figure 10.1b are explored in more detail in Section 10.2, but overall:

- The first obstacle shown on Figure 10.1a was general anxiety about, and unfamiliarity with computers. However the findings of the survey carried out at the start of the field work indicated that the 68 biology lecturers who responded were using computers extensively *outside* their classrooms and were therefore over this first obstacle; it therefore does not appear on Figure 10.1b.
- The study participants stressed that inadequate hardware resourcing was operating as a barrier to CAL use in FE biology teaching. The *location* of the resource was seen as particularly important, and the majority of those who were interviewed complained that hardware was generally located in central areas which were difficult to access, and that their classroom hardware resourcing was very poor (this

is explored further in Section 10.2). The interviewees' perceptions of the adequacy of their hardware resourcing were influenced by whether this hardware could run the software they wanted to use (arrow *a*) and whether it enabled the classroom activities to run smoothly (arrow *b*). The *actual* adequacy of their classroom resourcing was often influenced by individual departmental members who had lobbied for increased provision (arrow *c*).

- There appeared to be a close connection between hardware resourcing and CAL use. The majority of the survey respondents cited hardware resourcing as the main impediment to their use of computers in the classroom, and the interviewees who showed most increase in the level of CAL use during the two and a half years covered by the field work, attributed this increased use to improved classroom resourcing.
- The interviewees' perceptions of the adequacy of their software resourcing was influenced by a more complex set of factors. At the most basic level this perception was influenced by whether the available software could actually run on the available hardware (arrow *a*). Beyond this level, their perceptions of the adequacy of their software resources depended upon whether they perceived these resources to be useful (arrow *d*). The survey showed that the interviewees had strong *general* perceptions of the usefulness of software, but the interviews revealed that this was modified by problems to do with availability of suitable biological CAL (as explored further in Section 10.2). The interviewees' perceptions of the usefulness of *specific* software packages was influenced by a set of criteria (see points 7 and 8) and these included how far the software fitted with their personal philosophies about education (arrow *e*) and their classroom practice (arrow *f*). The perception was also

influenced by their colleagues (arrow g), as those who worked in open and communicative departments, with colleagues who were using CAL effectively, appeared to be able to modify various packages so that they were more in tune with their own classroom dynamics or philosophies of education (see point 9).

- There was a less obvious connection between software resourcing and level of CAL use. However, several of the survey respondents and most of the interviewees complained that there was a lack of CAL which was appropriate for FE level biology, and it was clear from the classroom observations that the teachers involved were prepared to overcome significant difficulties in resourcing and classroom organisation to use software which they felt was intrinsically useful.

2. As noted under 1. the thesis provides a survey of 68 FE biology teachers; this was done to establish some key elements concerning their current and previous use of CAL. Such subject-specific surveys are rare within FE, but this survey found the respondents' assessments of the usefulness of CAL appeared to be based on criteria which were specific to biology teaching, rather than on general pedagogical principles. Johnson (1997) found that colleges were carrying out a considerable amount of research into improving institutional performance or quality; much of this research focused on student achievement. In contrast, the thesis focus was on teachers and their current and previous use of computers, both at home and at work. This allowed an identification of the very low levels of CAL use amongst this group of FE biology teachers, but also allowed the identification of factors which did, or did not, impact on this use. For example, it revealed that there did not appear to be a relationship between the extent to which the teachers used computers outside their teaching and the frequency with which they used CAL. It also revealed that those who had been exposed to the use of

computers in HE were more likely to make use of CAL than those who had not.

3. The thesis provides the construction of a fuller picture, using both quantitative and qualitative methods, to show how the factors identified in the literature review interacted to influence CAL use in a group of FE biology teachers. Whereas the obstacle course provided a pictorial representation of *barriers* to use, this fuller picture concentrated on how these barriers might be navigated. Overall, the combination of the survey, interviews and observations worked well to provide different perspectives on these factors.

The key elements of the fuller picture were the teachers' familiarity with computers in the classroom and their perceptions of the usefulness of software. Classroom familiarity was particularly promoted by the teachers' previous exposure to the use of computers in education (e.g. in HE) and current exposure to their colleagues' classroom use of computers. The latter was particularly facilitated in open and communicative departments, where there was a sense of collaboration amongst the teachers. The teachers' perceptions of the usefulness of software are addressed in points 7., 8. and 9.. The fuller picture is described in more detail in Section 10.2.

4. As mentioned under 1., the thesis also provides an outline of the problems caused within FE colleges by the policy of centralising computing resources, and a description of the difficulties faced by these FE biology teachers in accessing adequate hardware resources in their normal teaching areas. This is described further in Section 10.2.

5. As mentioned under 1., the thesis provides a description of the difficulties involved in finding appropriate biological CAL for FE. This description addresses the difficulties encountered both in gaining access to programs and/or program reviews, and in finding

material which is suitable for the FE biology curriculum.

6. The thesis also provides an analysis of the responses of a group of FE biology teachers to a range of biological CAL, and an examination of how their degree of teacher- or student-centredness (as gauged using the Prosser et al (1992) framework) impacted on these responses. This analysis found that student-centred teachers were more critical about a range of tutorial programs and simulations than teacher-centred teachers. The student-centred teachers declared themselves less likely to use such programs in their classrooms; this finding does not support the contention of authors such as Hodas (1993) and Loveless (1996) that a teacher-centred stance mediates against the use of CAL.
7. The thesis provides a set of criteria which these FE biology teachers appeared to use when assessing the potential value of a variety of CAL programs. This is described in Section 10.2.
8. The thesis provides an identification of two main modes of using software in classrooms. In the first mode, the software is used as a pedagogical vehicle (for example, a simulation might be used to reinforce or introduce the topic of photosynthesis). Under these circumstances the software does not appear to be seen as central to the activities of the class, and the teachers evaluate the potential of the software using the criteria mentioned in 7.. In the second mode, the software is used as an end goal in its own right (for example, the Internet might be used because it is important that students are familiar with it). Under these circumstances the software appears to be seen as pivotal to the activities of the class, and the teachers are prepared to use it even if it does not fulfil the criteria mentioned in 7.. This is explored further in

Section 10.2.

9. The thesis provides an identification of a *modifier* sub-group within the interviewee group. The modifiers were prepared to use programs as pedagogical vehicles even when those programs did not match their personal philosophies for education or their classroom dynamics. The modifiers were able to suggest how they might modify the program's use so that any problems of mis-match were minimised. It became apparent that this group was characterised by having had exposure to computer-use in HE, and by currently working in open and collaborative departments. This is explored further in Section 10.2.

10. Finally, the thesis provides an exploration of the use of two frameworks (Prosser et al, 1994; Brown and McIntyre, 1993) in a context and with a purpose different to that with which they had previously been used. Both schemes were used to structure complex data.

The Prosser et al (1994) scheme was used to frame and analyse the teachers' conceptions of teaching and learning on a continuum from student- to teacher-centredness. The findings from the thesis indicated that the scheme could provide a valuable means of quantifying such conceptions and comparing them with other variables exhibited by the interviewees (e.g. critical views of software, as outlined in 6., above). The findings also indicated that the classifications had a degree of endurance across time; this had not been explored in the original study.

The Brown and McIntyre (1993) framework was fundamental to the structure of the classroom observations described in this thesis. It was used to assess the teachers' classroom dynamics, that is, the key aspects of their teaching style and classroom

management. The aim of its use in this thesis was to see how such dynamics were affected by the incorporation of classroom technology; the framework had not been used in this way before. The findings of the thesis suggest that the framework could be used to provide a valuable means of assessing how different kinds of technology impact on classroom practice.

10.2 Main findings of the thesis

This section is sub-divided as follows: Section 10.2.1 describes how key factors interacted to influence these FE biology teachers' CAL use; Section 10.2.2 outlines the implications of the findings for policy and staff development; Section 10.2.3 outlines the implications of the findings for software development.

10.2.1 The fuller picture

Following the literature reviews in Chapters Two and Three it was suggested that teachers faced a series of barriers in moving from being non-users of technology to being fluent users who could integrate technology into their teaching. The factors which made up these barriers were represented pictorially as an obstacle course (see Figure 10.1a). The field work described in Chapters Four, Six, Seven, Eight and Nine investigated the interaction of these factors in order to establish how teachers might navigate the obstacle course and increase their use of CAL. The purpose behind this investigation was that the findings could be used by those who influence FE policy, staff development and software design, to find ways in which they could help teachers make more use of educational technology.

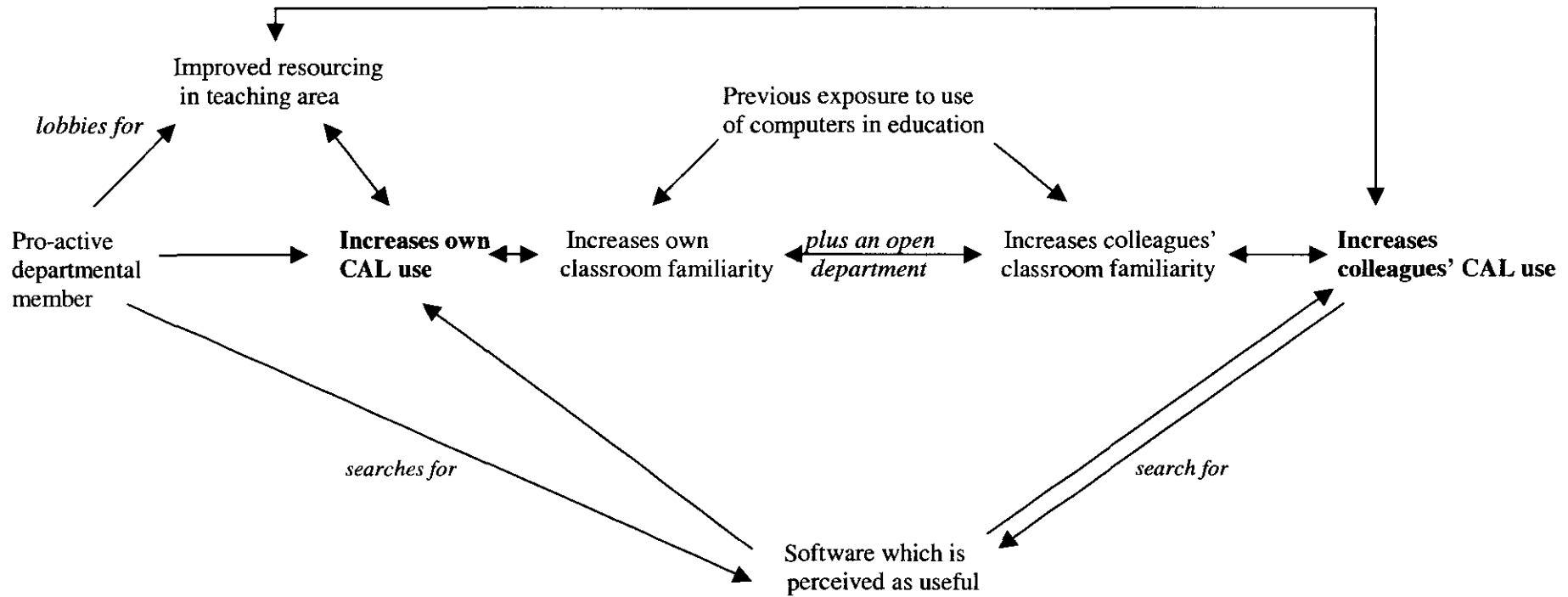
The findings from the survey indicated that the respondents were using computers regularly outside classrooms, and so were mostly over the first obstacle. The rest of the

research therefore focused on factors occurring in the second and third obstacles. Some of the key findings are illustrated in Figure 10.2, overleaf, which is a simplified version of Figures 8.1 and 9.1. These findings suggested that two factors were particularly key in promoting increased use of CAL. The first of these was classroom familiarity with the use of CAL and the second was perceived usefulness of software. These are addressed in turn.

Classroom familiarity

This took a central position within the obstacle course, as can be seen from Figure 10.2. It was clear that some respondents were achieving classroom familiarity in an isolated way and primarily by their own efforts. It was also clear that the efforts of other respondents were greatly boosted by their previous exposure to other educators' use of computers in classrooms (e.g. during their HE studies) or (in a minority of cases amongst the interviewee group) by their current exposure to their colleagues' use of computers in classrooms. For the latter to occur it seemed as though the individuals needed to be working in departments which were relatively open, in that there was a sense of collaboration in their workplace, and in that they had a strong awareness of how their colleagues were using CAL in their classrooms.

It seemed that the initial impetus towards the departmental use of computers in classrooms had generally come from one individual. In many cases these individuals were still working in isolation. However, in the more open departments the situation had become more collaborative, and others were sharing the burden of lobbying for better hardware resources and searching for better software. Following the Second Interviews it was suggested that collaborative departments encouraged individuals to a



arrows show direction of influences

Figure 10.2 Some key findings on how hardware resourcing, classroom familiarity and access to useful software influence teachers' CAL use

greater use of CAL partly because this burden was shared, and partly because the individuals learned from their colleagues different ways of *modifying* the use of software so that it fitted better with their classroom practice.

Less than half of the interviewees were identified as *modifiers*. These individuals spoke about how they would adapt the use of the programs they were reviewing so that any perceived problems could be overcome. Because of this modifying tendency, these individuals had a more flexible approach towards the use of software in their classrooms than the other interviewees. It was noticeable that the modifier group was characterised by having had exposure to the use of computers in HE while they were students, and by working in open and collaborative FE departments.

Access to software which is perceived as useful

During the Second Interviews it became clear that the CAL needed to “fit” their requirements in several clearly defined areas, if the interviewees were to perceive it as useful for classroom integration. Chief amongst these were the interviewees’ requirements for syllabus fit, information fit and interaction fit. Once these criteria were satisfied the interviewees then moved on to consider aspects to do with classroom activity; at this stage most of them appeared to debate the benefits of the program against the costs of trying to integrate it into their teaching.

Following the observations it appeared that most of the issues to do with ‘fit’ were accounted for by Brown and McIntyre’s (1993) concept of the NDS. Where the NDS of the program matched the teacher’s NDS, then integration problems were minimised. Under these circumstances the teachers indicated that they found the program useful. However, from the observations it also became clear that if the teachers perceived the

software to be intrinsically useful, then they made considerable efforts to overcome problems of resourcing, time, interaction and classroom integration, in order to use that software with their students. This “intrinsic usefulness” correlated with Brown and McIntyre’s (1993) concept of Progress and was often directly linked to syllabus requirements.

It was interesting that software which came under the intrinsically useful category included experimental interfacing and the Internet, that is, applications which would both be used in the workplace. This observation appeared to be in line with Cuban’s (1993) prediction that computers, unlike many other kinds of educational technology, will slowly change schools, because they have become indispensable in the world of work.

10.2.2 Implications for policy and staff development

The fuller picture described in Section 10.2.1 indicated the importance of classroom familiarity and access to useful software in the development of increased CAL use. Information from the survey and interviews found that teachers considered resourcing to be crucial in allowing them to develop their use of CAL. The implications of these observations for policy and staff development are addressed in this section.

Chapter One outlined some of the major developments which are currently occurring in FE. These include the five-year QUILT programme, which is designed to increase the effective use of ILT; staff development assumes a key position within this programme (Scribbins, 1997). However, it is possible that the main efforts of the QUILT programme will not be directed towards the use of technology in *classrooms*. Gray and Warrender (1995) noted in their review of the use of technology across 23

colleges, that considerable investment had been made in building up *centralised* computing facilities. They suggested that teachers were increasingly expected to spend more time with their students in these centralised areas and that both teachers and managers saw this as a way of decreasing staff costs.

Endorsements of such shifts are clear amongst FE managers, despite the coyness evident in the Higginson Report (1996) (see Section 2.1). For example, the Chair of the National Association for IT in Further Education (NAITFE) noted that there was a need for a

“re-allocation of resources which have previously been applied to more traditional and proven methods of delivering learning . The resource shifts inevitably mean a shift from staff resources (70 – 80% of any college budget) to technology and learning resources ... leaving the administration of the student experience in less specialist hands.” (West, 1994, p. 8).

It was clear during the fieldwork for the thesis that all the interviewees were experiencing the effect of centralised hardware resourcing. It was also clear that several of them were in agreement with Loveless (1996) that such distribution

“[denies] teachers the flexibility of deciding when technology should be incorporated into instruction, [and unwittingly conveys] to students that computers are not central to learning and certainly not central to the activities of their classrooms.” (Loveless, 1996, p. 451).

However, despite Gray and Warrender’s (1995) observations about changes in teaching practice, none of the interviewees appeared to be formally timetabled with their students in the learning or resource centres. In fact they often focused on the difficulty they had in gaining access to these centralised facilities with their students. This situation is obviously problematic, particularly bearing in mind the increasing number of policy advisory reports which suggest that:

“unless access [to communication technology] is distributed throughout the educational establishment it will not become embedded in the life and work of the classroom” (BECTa, 1998, p. 120).

The QUILT programme is also investing heavily in ILT development projects, and the Chair of its Advisory Committee commented:

“perhaps the biggest challenge we face is to create a body of relevant, stimulating and high quality learning materials” (Scribbins, 1997, p.2).

However, as noted in Chapter Eight, a review of these development projects, based on information from the QUILT website and on information from FEDA-funded research into ILT evaluation (Barnard, 1999b), suggests that they are, for the most part, designed to be used either off-site or in resource centres. Most of the ventures are cross-college (e.g. involving the development of careers programs or software designed to improve key skills) and there is very little development of subject-specific software.

The overall effect of these policies on the biology teachers involved in this research was that they were left with very poor computer resources in what was still their main work area, (i.e. classrooms or laboratories), and there was little indication that this situation was going to change. Therefore, if FE policy programmes aim to increase teachers’ use of educational technology in their everyday curriculum delivery, then there either has to be a massive move of teachers and students away from classrooms and into resource centres, or there has to be an acknowledgement that there is a need to devote some resources to classrooms. Unless the former happens in the near future, staff development programs will need to specifically target classroom use of technology.

The findings from this thesis suggested that classroom use of technology was best encouraged in open and communicative departments, where one individual had

provided the initial momentum and this had then developed into a more collaborative effort. However, most of the interviewees were working in more closed departments, where they were often not sure what their colleagues were doing in their classrooms. This then inhibited their opportunities to learn how others were integrating software into their classroom practice and to develop modifying abilities. It was suggested that staff development programmes could benefit from addressing how they might increase openness and collaboration, for example, by incorporating aspects such as timetabled double-staffing for individuals using CAL.

Watson's (1993a) findings also need to be considered if such a scheme is to be effective. Watson found that good practice in using IT did not readily diffuse from one individual to his or her colleagues, possibly because:

“successful use had become associated in colleagues' minds more with the individual characteristics of the user.” (Watson, 1993a, p. 273).

She proposed that staff development programmes needed to find a way of “depersonalising” the use of IT in order to encourage its wider use.

It was suggested in Chapter Seven that this phenomenon might have been responsible for the observation in the thesis research of the lack of diffusion of IT use from two comparatively frequent CAL users to their colleagues. It was proposed that this lack of diffusion might have been attributable to the fact that the individuals in question were very confident and expert computer users. In the light of this it was suggested that any double-staffing initiatives might need to be carefully considered so that less experienced CAL users could be supported, or “scaffolded” (Bruner, 1986), in their development, by working with individuals who were not much further ahead. In general, staff development is run by experts for novices; the findings here suggest that

this may be an apparently obvious, but not effective and long-term solution.

Finally, it often appeared during the Second Interviews that the interviewees rejected programs because they did not satisfy criteria which had a point of origin external to the teacher (e.g. syllabuses). Additionally, it emerged through both the interviews and observations that traditional classes, such as A-level, which were primarily examination oriented, very information dense and subject to considerable pressures in terms of time, appeared to be less conducive to the extensive or imaginative use of educational technology. This is an area which requires further investigation, but has significant implications for both policy and software development.

10.2.3 Implications for software development

The findings suggested that it was useful to view two different types of software use in the classroom. The first type involved software which was pivotal to the class in that its use was seen as an end goal (e.g. it was important that the students were familiar with using the Internet, because this was an significant application in “the real world”, and it was important that the students were familiar with the use of graticules because these were used “in the real world” and their use was prescribed on the syllabus). The second type involved the use of software as a pedagogical vehicle (e.g. a CD-ROM which could demonstrate animal movement). Obviously the two are related, and applications such as the Internet can also be used as pedagogical vehicles, however, it became clear during the research that the teachers had different criteria for establishing the perceived usefulness of the software involved in the two different types of use, as outlined in Section 10.2.1.

If the teachers saw the use of an application as an end goal in itself, then they were

prepared to use it despite problems with aspects such as resourcing and fit with classroom dynamics. However, if they saw the use of an application as a pedagogical vehicle, then they had much more detailed demand of it, in that they required it should:

1. fit into their syllabus area
2. meet their demands for information quality in terms of clarity, consistency and, where appropriate, pedagogical slant **or** have the potential to be used in a way which could overcome any shortfall
3. meet their demands for user engagement **or** have the potential to be used in a way which could overcome any shortfall
4. demonstrate a value which meant it would worth using in the classroom despite integration problems (e.g. time) **or** demonstrate a value specifically for classroom use (e.g. in enabling students to work independently in a classroom setting, or adding variety)
5. (as an added bonus) overcome a specific pedagogic problem (Draper, 1998).

It is suggested here that any software development which is designed for classroom use needs to consider whether it is, either, likely to be pivotal to the proceedings, or, likely to be used as a pedagogical vehicle. If it is the latter then most of the previous five criteria need to be satisfied for it to be perceived as useful.

As noted previously, the researcher's experience in trying to collate the software pool, and the comments by the interviewees on their own attempts to find software indicated that biological software, particularly for A-level or equivalent, is difficult to find. This difficulty relates both to the accessibility of information about the programs and their suitability for the FE curriculum. It also became clear during the research that this was in contrast with the position in HE where many programs were developed in-

house, and where CTI initiatives provide valuable information dissemination. With respect to suitability, it is not clear how far the lack of appropriate software is determined by the limited prospects of sales for biology A-level, or equivalent. As noted earlier there is the potential for QUILT funded, in-house software development, but currently the software emerging from the QUILT programme is not aimed primarily at classroom use.

It was particularly striking that the student-centred teachers were more critical about currently available biological CAL than the teacher-centred teachers, primarily because it did not accord with their student-centred approaches. It would seem imperative that software developers address this problem if their educational programs are to be seen as pedagogically sound, and if the use of such programs is to spread throughout the FE sector.

Finally, it emerged from the interviews that the teachers were particularly keen on software which could overcome specific pedagogical problems; such software is described by Draper (1998) as showing niche-based success. This success is context-specific, and the development of the software needs to include input from individuals who are very familiar with the context (e.g. the teachers). The interviewees who took part in the software reviews for the Second Interviews were, for the most part, able to produce very rich evaluations for a program in a short time. It is suggested here that those software developers who do not involve teachers are missing a valuable, and relatively cheap, element from their design process.

Overall, the picture which emerged from the research showed that the low use of CAL amongst the biology teachers who were involved could probably be alleviated by a combination of better resources, more collaborative work with computer-using

colleagues, and access to better software. However, it was also clear that many of the interviewees were working in circumstances where these three key elements were missing from their work environments.

10.2.4 Implications for research

The field work and analysis used two externally derived frameworks; in both cases it showed that these frameworks could be used with groups, and in contexts, different to those with which, and within which, they were developed.

As noted earlier, the Prosser, Trigwell and Taylor (1994) framework was used to gauge the teachers' conceptions of teaching and learning. These conceptions were then matched against other factors emerging from the interviews and observations, such as attitude towards software. This use of the framework provided a means by which the educational philosophies of a relatively large group could be classified and compared, and by which their impact on other factors could be assessed.

More extensive use was made of the Brown and McIntyre (1993) framework. An understanding of classroom practice is seen by many researchers (e.g. Kerr, 1991) as the key element in an understanding of the uptake of innovations, however, classroom practice, with its many variables, is very difficult to study. The use of the Brown and McIntyre (1993) framework in the thesis suggested that it was possible to identify how software could cause an important shift in teachers' classroom organisational focus. In the light of this it was suggested that the framework could be applied to track teachers' experiences of incorporating innovations into the classroom.

10.3 Limitations of the research

The scope of the research was restricted by difficulties in negotiating term, timetable and syllabus constraints, and the findings would have benefited from the opportunities either to interview and observe more individuals, or to spend more time interviewing and observing the same individuals. However, FE is currently a politically sensitive and very demanding work environment, and it was not possible to ask for more involvement from the participants than they had already given. Beyond these generally applicable limitations there were some which were specific.

The research focused on biology teachers in FE and it is not clear how far the findings are generally applicable to other sectors and other teachers, particularly considering that these teachers' use of CAL was constrained by the availability of suitable biology software, and the policy of centralised resources in FE. The research group was also generally enthusiastic about the use of CAL in education, and the findings may have less relevance for individuals who are inherently opposed to its use.

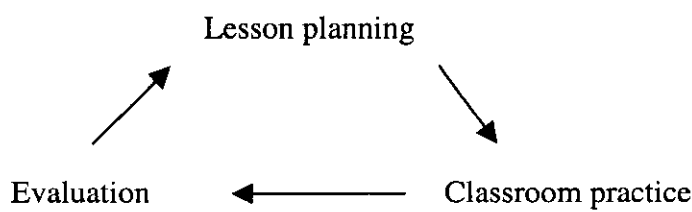
There were factors from the obstacle course which were difficult to investigate thoroughly. One of these was resourcing. This emerged strongly from the literature review, the survey and the follow-up questionnaire, as being vital with respect to CAL use. However, it was difficult to map out the full effect of resourcing based on the information gathered during the interviews and observations. This seemed to be because resourcing issues only emerged when the interviewees were questioned directly about their effect. When the focus of the questions was on some other aspect of their work environment the interviewees tended not to talk about resourcing constraints. This was evident in the Second Interviews and observations, and also appeared in Brown and McIntyre's (1993) account of their own study. Overall, this appears to

point to a need for direct examination of resourcing issues. In the light of the findings which emerged from the follow-up questionnaire, it was also suggested that resourcing issues might emerge more clearly through longitudinal studies.

Another factor which was difficult to investigate fully was classroom dynamics. Following the pilot study it was suggested that classroom dynamics had a profound effect on other factors from the obstacle course such as resourcing, perceived usefulness of software and personal philosophies about teaching and learning. Although the observations shed some light on the influence of classroom dynamics on these factors, the connection was difficult to explore. Brown and McIntyre (1993) suggest that factors such as resourcing might not emerge through a study of classroom dynamics, because

“.. may be that by the time the teacher reaches the classroom, he or she has already become resigned to making the best of what is available.” (p. 78).

In the light of this and the researcher’s own observations it is suggested that a great deal of rich information might emerge from studies which combine classroom observations and subsequent evaluations with an examination of the teacher’s lesson planning, that is, from research which examines the whole cycle, i.e.:



The other limitations of the research were as follows.

Firstly, because of the practicalities of the Second Interviews, it was not possible to carry out a broad assessment of the response of a relatively large number of teachers to important applications such as interfacing and the Internet.

Secondly both the Second Interviews and the observations relied on the teachers' abilities and willingness to articulate their ideas about software and their own classroom practice. The findings from the observations and interviews had coherence on a number of issues, and this gives them added confidence, however, there is still the need to be cautious about this issue.

Thirdly, both the First Interviews and the observations used frameworks which were developed under a different context and with a different purpose. Although these frameworks provided a valuable means of analysing and comparing the data it is, as with all frameworks, unclear how far some of the richness of information about teachers' philosophies on teaching and learning, or thoughts on classroom activities might have been lost because of this.

10.4 Further Research

The research highlighted a number of key questions all of which could benefit from further investigation. These included the following:

In terms of FE biology teachers' use of software

1. The policy of centralising computing resources in FE is seen by FE teachers as having a detrimental effect on their use of educational technology. It is suggested that this policy needs to be monitored to see how far it mediates against the uptake of CAL within the FE teacher's "normal" teaching.

2. Traditional intensive syllabuses (such as A-level) appeared to inhibit the innovative and/or extensive use of software. It is suggested that this could benefit from further investigation.

3. Problems were encountered in the fieldwork in trying to assess the impact of resourcing on the teachers' use of CAL. It is suggested that this area could be investigated better using longitudinal studies which directly address the resourcing issue.

In terms of software development

1. Very few of the QUILT development projects are aimed at specific subject areas. In the light of this it is suggested that it will be important to assess their impact on the "normal" classroom activities which still make up the bulk of the educational provision in colleges.

2. There is currently a paucity of software which is suitable for FE level biology. An assessment of development costs is needed to see how far it is feasible for independent producers to develop such programs in terms of cost, or to see how far in-house developments will be able to provide the material that is needed.

In terms of staff development:

1. It was suggested in the thesis that increased CAL use might be achieved by a staff development programme that included timetabled double-staffing. It would be worth investigating the cost effectiveness of such a programme, particularly as many apparently less costly programmes are seen as having little effect on teachers' CAL use.

2. As part of this, it would be important to evaluate how far such a programme would

encourage the development of open and collaborative departments, and how far the avoidance of an expert/novice pattern of staff development would promote the diffusion of CAL use.

In terms of classrooms and computers

The thesis findings indicated that the Brown and McIntyre (1993) framework had potential in assessing the effect of educational technology on classroom practice.

However, the findings also suggested that the framework did not allow full consideration of aspects such as resourcing and the influence of personal philosophies about teaching and learning. It was suggested that these factors needed to be examined *within a cycle which included lesson planning, classroom action and evaluation*. It is proposed here that longitudinal research could be carried out using the Brown and McIntyre (1993) framework, to, firstly, map the shifts in the interactions between a teacher's lesson planning and their classroom practice, and, secondly, assess how far such a map could contribute to an increased understanding of how teachers respond to educational innovations. This research would follow on naturally from the research described in this thesis, and would provide a rich area of exploration, both in terms of educational practices and in terms of methodology.

In general terms of evaluating policy decisions

Finally, the work described in this thesis used a variety of methods to build a picture of FE biology teachers' use of CAL. At a time of considerable change within the FE sector where costly policy initiatives are intended to produce significant shifts in how the curriculum is delivered, such a picture illustrates the complexity of the situation 'on the ground'. The sector's drive for corporate efficiency means that resources have been

directed towards evaluating productivity, but there has been little assessment of the everyday impact of policy changes. The findings of this thesis indicate that there is a need for in-depth studies to monitor and evaluate the changes which are being pressed for across the FE sector.

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Appendices

Appendix One	Questionnaire
Appendix Two	First letter to survey respondents
Appendix Three	ITTE survey template
Appendix Four	Responses to the open-ended question
Appendix Five	Script for the First Interview
Appendix Six	Second letter to survey respondents, including software details
Appendix Seven	Follow-up questionnaire
Appendix Eight	Letter from Donald McIntyre (1998)

Appendix One

Questionnaire

Please answer the following questions in the space provided.

1. Are you male _____ female _____ (please tick)
2. Approximately how many years have you been teaching? _____
3. What subjects do you teach/ have you taught? _____

4. What levels do you generally teach? (please tick)
- | | |
|---|-------|
| GNVQ1/ foundation or equivalent | _____ |
| GNVQ2/ GCSE/ BTEC First or equivalent | _____ |
| GNVQ3/ A-level/ BTEC National or equivalent | _____ |
| degree level or equivalent | _____ |
| other (please specify) | _____ |

5. What subject/s did you study at Higher Education?
-
6. a) Did computers play a role in your Higher Education Studies? (please tick)
- yes ____ no ____
- b) If you answered "yes", in what capacity (e.g. word processing, data analysis, learning programs)?

Please tick the most appropriate answer.

- | | at home | at work |
|-----|---------|---------|
| yes | _____ | _____ |
| no | _____ | _____ |

2. If you have access to a computer at home, which of the following do you use it for (tick as many as apply)

word processing	_____
spreadsheets	_____
statistical analysis	_____
graphics	_____
electronic mail	_____
CD-ROM	_____
internet	_____
programming	_____
games	_____
other (please specify)	_____

3. If you have access to a computer at work, which of the following do you use it for? (tick as many as apply)

word processing	_____
spreadsheets	_____
statistical analysis	_____
graphics	_____
electronic mail	_____
CD-ROM	_____
internet	_____
programming	_____
games	_____
experimental control interfaces	_____
other (please specify)	_____

4. If you use computer based learning packages as part of your teaching,
a) please give an indication of how often (e.g. weekly, monthly etc)

for Biology _____
for other subjects (please specify which these are).

b) please name below any packages which you use regularly, and, if possible, indicate what category they belong to (e.g. tutorial systems, data analysis, simulations)

How much work-based training have you had for using computers?

	none	up to 5 hours	up to 10 hours	more
for word processing	_____	_____	_____	_____
for spread sheets	_____	_____	_____	_____
for using learning programs within your teaching	_____	_____	_____	_____
for other computer based activity	_____	_____	_____	_____

Where would you go to for help and advice with your use of computers in work?

7. And finally, a wide open question! Are you enthusiastic or optimistic about the use of computers within your teaching area? Could you give reasons for your answer?

8. Any other comments?

Many thanks for your time.

Personal Details

Name:

College Name and Address:

Contact telephone number:

Would you be willing to: (please tick)

	yes	no	possibly
--	-----	----	----------

be interviewed			
----------------	--	--	--

try out some software			
-----------------------	--	--	--

be observed in the classroom using software			
---	--	--	--

Appendix Two

First letter to survey respondents



The Open University
Wilton Hall
Milton Keynes
MK7 3AA
Telephone: (01908) 274066
Direct Line (01908) 65
Fax: (01908) 654373

Institute of Educational Technology

16th February 1996

Dear Biology Teacher

I am starting an investigation into the problems faced by teachers and lecturers when using computers in the classroom. The aim behind this is to provide advice for those designing educational software.

The enclosed pilot questionnaire marks an attempt to map the general usage of computers by Biology teachers. I would be very grateful if you could take the time to complete it and return it in the pre-paid envelope.

The questionnaire is anonymous, however, if you are willing to become involved in further studies would you please fill in the page headed 'personal details' and enclose it with the questionnaire.

Please telephone me if you need clarification of any of the points covered in the questionnaire.

With thanks

Jane Barnard

Personal Details

Name:

College Name and Address:

Contact telephone number:

Would you be willing to: (please tick)

	yes	no	possibly
be interviewed			
try out some software			
be observed in the classroom using software			

Appendix Three

ITTE survey template

- 6.3 Use 'aliases' or an Address Book to send email messages to groups of users using prepared text
- 6.4 Subscribe to and unsubscribe from an automatic email 'list'
- 6.5 Explain the advantages and disadvantages of using a text based 'conference' to exchange ideas
- 6.6 Send and receive files prepared with a word processor or spreadsheet using email

Information Services

- 7.1 Search an electronic library catalogue and find books by author, subject or keyword
- 7.2 Use a World Wide Web browser to view pages and follow links
- 7.3 Use a World Wide Web browser program to select and save text, pictures or program files and other information from remote sites
- 7.4 Use a 'Search Engine' site to find information on the Internet and refine the search, if required, using two or more search terms
- 7.5 Design and create a series of HTML pages for use as part of a local Intranet Web service to communicate subject information

ITTE

DRAFT VERSION -- August 98

OMR form includes response fields to collect additional information:

- Course
- Age
- Gender
- Access to IT resources
- Computer use

IT Survey Association for Information Technology in Teacher Education

This survey of IT capability will help us to develop a programme of training for you which will help you to carry out your work as a teacher more effectively. **Please be as honest as you can** - Remember that you may not have worked with many of the applications before.

Read each of the generalised activity descriptions that follow and then for each one mark the OMR form responses that you feel best fit your own level of skill. – if you do not recognise or understand the activity use the 'no experience' option

[Competent – could help a friend] [Reasonably competent] [Limited or no experience]

Don't panic if you have to say 'no experience' to almost everything!

Next complete any additional sections of the optical mark reader (OMR) form.

Overall Summary of Competence with different applications

1.1	Word processing	1.9	Spreadsheets
1.2	Databases	1.10	Graphics Packages
1.3	Find information on the World Wide Web	1.11	Desk Top Publishing
1.4	E-mail	1.12	Logo
1.5	Computer Conferencing	1.13	Data Logging
1.6	Find Information on a CD ROM	1.14	Control Technology
1.7	Programming Languages	1.15	Modelling and Simulation Software
1.8	Web Page Design	1.16	Multimedia Authoring

General Skills

- 2.1 Use a graphical user interface (e.g. Windows)
- 2.2 Select and run an application using a mouse

- 3.7 Make use of special character sets for mathematical or foreign language materials
- 3.8 Use macros or templates to enable you to work more effectively

Information Handling - Databases

- 4.1 Search a database for information using simple keywords or phrases
- 4.2 Search a database using two or more search words combined using AND, OR or NOT to make the search more specific
- 4.3 Use a database programme to extract and represent information in the form of reports, charts or graphs
- 4.4 Distinguish between different sources of information in terms of validity and reliability
- 4.5 Design and create a database for a particular application and document its use for others

Information Handling - Spreadsheets

- 5.1 Use a spreadsheet to store and print lists and tables
- 5.2 Use a spreadsheet to sort or select particular kinds of information
- 5.3 Use a spreadsheet to calculate results using formulae in cells
- 5.4 Use a spreadsheet to produce reports, charts or graphs
- 5.5 Design and create a spreadsheet for a particular application and document its use for others

Email

- 6.1 Send, receive and print email messages
- 6.2 Organise saved email messages into electronic 'folders'

- 2.3 Cut, copy and paste material using a mouse
- 2.4 Format and copy discs
- 2.5 Create new directories or folders and organise the way that files are stored on a hard disc.
- 2.6 Create 'Back Up' copies of important files and restoring them when required
- 2.7 Carry out virus checks on your floppy discs and 'fix' problems
- 2.8 Select and set a printer option
- 2.9 Connect input and output devices (e.g. mouse, keyboard, printer)
- 2.10 Size and switch between several concurrent applications
- 2.11 Use the basic facilities provided by a computer network and use these to transfer files between the computer and other network computers
- 2.12 Create links between different program windows that share the same information. (e.g. a report using charts linked to spreadsheet so that it is updated as the spreadsheet changes)

Word Processing

- 3.1 Enter text, correct errors, save and re-open text files, print.
- 3.2 Format text; change font and text sizes, margins and indents, paragraph layouts, etc. Use spelling checkers and other proofing tools.
- 3.3 Use more advanced document design techniques: include and position pictures and diagrams, tables and graphs etc.
- 3.4 Design and edit documents so that they are appropriate for different purposes and audiences.
- 3.5 Use 'mail merge' to prepare personalised forms or letters.
- 3.6 Create a sequence of computer display screens for a presentation using a presentation manager such as PowerPoint

Appendix Four

Responses to the open-ended question

1.

Yes but only for some situations eg. when the program fits in neatly with teaching areas. (CAL)

Also to introduce CAL to students on low level courses, especially to those who have had little contact with them before.

2.

Not optimistic - class sizes grown too large

3.

Computer simulations allow students to carry out 'experiments' which would otherwise be unethical. They are a useful adjunct to other modes of teaching. More simulations of the level of the 'Mac' series would be welcome

4.

I would happily use helpful programs in the teaching situation if the outdated machinery were replaced. The BBC's were pretty unsightly 5 years ago when we were 'given' them. It's embarrassing to get them out in 1996. We didn't even have a colour monitor until the merger this Autumn!

This is an area that the recent inspection report was critical of. I hope that management will respond in a positive way.

5.

Computers have their uses but there are cost problems. Some of the packages available really need fast computers and high speed/capacity networking facilities and these are not readily available for subjects outside computing.

Use of computers in teaching comes down to being a resource issue - computing resources, time to learn the package in question and to produce a realistic set of teaching / learning notes. More and more pressures are being placed on time and less and less money seems to be available for new physical resources. Therefore presently not particularly optimistic.

6.

Until we have computers and software for all students in a group their value is limited. We are held back by lack of investment, but I'm pushing.

7.

Yes, but main difficulty is financial resource (or lack of!). Site licenses for multiple copies, availability of networks to run packages, time to learn how to use them. Cellular Pathology is a very visual subject and CDROM technology can be very useful for storage and retrieval and constructing interactive packages

8.

Have no experience of use of computers within biology would like to become involved, but lack time to become familiar with use of computers.

9.

Hopeful (naively optimistic) Biology: Resources difficult to obtain: recently upgraded to a 286!! still wheeling and dealing to get a VGA monitor + board. College resources go straight to wordprocessing etc.

Money been spent on data collection boxes but college still to accept that modern computers are needed as well in order to run them

10.

Analysis is much easier + quicker

-Possible to access information using CD ROM in library.

11.

Moderately so -

- it is important to integrate IT into vocational education
- I have no experience of using learning packages, I can see they would be useful but think personal contact with students is still vital for successful teaching

12

yes (but) for information storage, retrieval and data handling. The present generation of students have been brought up with computers and use them for wordprocessing, data analysis etc - the computer has become part of life in this respect. More information is now becoming available on the internet eg gene web which contains data that can be used by MSc and BSc students in the subject areas I teach - there are also many other databases on line with relevant information and journal access is becoming more available.

I also see E-mail becoming widely used in courses based on distance learning.

I do not know of any suitable "learning" packages for BSc (Hons), MSc. -

Immunology/Biomedical sciences so I cannot predict increased use in this area.

13.

Both - there are lots of nice CDROMs about for Biology!

14.

Very much so!

- 1) Computers are becoming normal tools in everyday life
- 2) Rapid accessibility of information
- 3) Potential for simulations
- 4) Experimental recording of measurements
- 5) Professional appearance to work produced
- 6) Potential for tailored student-centred learning programmes

They're still too expensive to be readily accessible in all labs - but not for long.

Software is getting better, but it still needs developing.

15.

If the packages were suitable, they should be a very valuable aid to teaching, but some packages I have seen take up too much time in an institution where many courses are only 1 year and if the syllabus is difficult to complete. Packages need to be designed as an alternative to classroom teaching, not an add on.

16.

Yes - but time consuming

detracts from "proper teaching"
and tutorial groups too large

Use PC for reactions timers. progress of reactions. Data collection. All WP skills - self taught - as textbook author.

17.

Yes - stimulation of students
data crunching
ability to illustrate concepts not readily grasped from books

18.

Would love to use computers as part of my teaching - but no facilities in laboratory in which I teach.

19.

No facilities at present but would be enthusiastic and willing if money for equipment could be found.

20.

Little money available - would like to use packages far more but few available - computers are out of date in our department.
I have no specific training in use of packages.

21.

I am both enthusiastic and optimistic, as the use of computers could open up opportunities for many students. However, the materials that would make good teaching materials are not yet widely available. Some interaction needs to occur between student and machine. The majority of CD-ROMs are still basically books on the screen.

22.

Very useful for students to be able to produce good assignments with graphics

23.

I look forward to the introduction of the internet facility

24.

Yes I am. Particularly the use of virtual reality. It would be great to be able to 'walk' through a cell avoiding the nucleus watching the mRNA wizzing by - it would bring turgid areas of the subject alive.

No I'm not - when they are used instead of 'up the front' teaching and not to enhance it.

Funding for IT in our area is very poor. we have purchased data logging equipment from Philip Harris but have now been waiting 6 months for approval from our finance people. Even if we are granted money to buy it, it will still not be enough. Each lab should have a stand alone PC, several data loggers and probes and possibly a lap top for field work.

IT in sciences needs to be funded @ goverment level??

25.

Enthusiastic and optimistic -because IT is a valuable resource which enhances certain aspects in science which for many have been difficult to grasp. Data analysis is an

important area in science. Also there are many packages available that simulate processes - animation etc..

Information data bases such as the Wellcome Trust Medical Science facility gives one access to up-to-date info on a wealth of topics world wide.

All these are just the beginning. If science teaching is to keep up to date and attractive to students then IT must be part of this equation.

26.

Yes. I find it very useful at home but as yet have not used one in college.

27.

Yes, for flexible learning, simulations and statistics use mainly.

Educational material is far too expensive

28.

I have discovered a number of packages now related to A level text books and revision programs which would be helpful. Most programs have been rather disappointing or much too complex.

The need for adequate technicians to cope with these have proved a problem.

29.

NO. One computer for upwards of 30 students is not suitable and most of the packages I use are my personal property, i.e. paid for by myself and therefore only able to be installed on one machine at any one time because of copyright/prohibitive site licences.

30.

Optimistic - there are a lot more programmes now available esp. CD ROMs which would enhance teaching.

31.

Yes but cost/time etc all problems.

32.

-All very new to me - I took a break from teaching to have a family - returned to teaching to find computers but because I have been part-time have not had the time (or energy!) to get to grips with them - I'm sure when the time comes I will be enthusiastically converted!!

33.

Yes. The use of Ecosoft has been particularly successful. I now design a River Study around one aspect of this package -studying pollution using indicator species in River. When the students have typed in their data they get an instant read out of the pollution level of the river. This an excellent confidence builder for new adult Access' students. Limitations - one computer in the lab for 15 students.

Data logging has been disappointing. I can't rely on it to work every time. It takes time to set up which I haven't got.

34.

Enthusiastic as I enjoy using them. I'd like to use them more as the college gets more. But they're best with small groups or individuals and are they cost effective.

35.

As a previous computer coordinator who introduced the first ILEA 'batch' processing for programming in the early FE Computer Studies syllabus I guess that twenty years ago I was enthusiastic and a walk through any modern research or industrial laboratory confirms that. (P.S. Now an inescapable management tool).

Older teachers are still 'computer phobic' computers are however part of the last ten years of youth culture and use as 'machines' is easy. However the block is the tutor support for using them as learning resources. I am committed to "flexible" and open learning and as a Science Director will resource these fully.

However there is a great job of work to do in training the teachers who support learning in computer resourced environments.

36.

Enthusiastic but not too optimistic

-lack of training and resources (eg CD ROM) makes me less optimistic than I might otherwise be.

Also, level of optimism reduced by lack of time to gain experience.

37.

Yes, but I have not yet used them

38.

Yes - with reduced teaching hours, self-learning packages based on interactive computer software could be invaluable. But, cost of programs quite high considering they generally cover such specific topic areas. Also, we would need several computers in the Biology area so that several students could work at the same time in either the same or different areas.

39.

Yes, more packages are becoming available and are more accessible to class via OHP.

40.

YES - with some reservations.

. Personally I prefer books to CD ROMs - because more variety - CD ROMs so far very limited (see exception - Sci Pictures - Toole and Toole).

. Pencil and paper graphs valuable exercise.

POSITIVES

-Flexible learning - use of this will increase

-CD ROM will be very useful for New Scientist - is to be "loaded" next week. Find paper index very difficult to use.

-Class spreadsheeted results convenient and useful intro to spread sheeting -with - purpose.

-Love the logit - but only used for yogurt and fermentations so far. Plan to use for environment. The chemists use it. Ought to devise a photo-synthesis experiment using light sensor shortly.

-I enjoy using computers and so do students. In my heart of hearts I think pens and paper take a lot of beating.

-Revolutionised production of handouts, tests, assignments, homework, classlists etc.

Word processor has changed my life far more than anything else to date.

Haven't tried simulations because haven't seen them in use. I like the idea providing they seem "impressive". Seem to be expensive.

41.

Presentation skills enhance work.

42.

Generally enthusiastic - particularly in research or illustrative contexts - or student development in use of computers for production of assignment work.

IT learning packages need to be more learning programme specific e.g. GNVQ A-levels

43.

Yes. I feel the opportunity for providing interactive problem solving opportunities for students is enormous as is the possibility of simulating physiological processes and experiments.

Specific training for staff is as important as the availability of resources.

44.

Bit of both, without going "overboard" - improved quality of personally produced learning support materials.

45.

CD Roms now appearing in learning centre - but cash restricted -Good for data retrieval. expect that area to grow and be useful.

Have trialled several interactive biology packages for use by students over the years - none worth the time taken (so far)

Have been taught to use a timetabling package -though (as usual) - have never seen the manual that goes with it.

46.

Yes I am very enthusiastic however my enthusiasm is constantly dampened by 'technical hitches' - network down/packages become out of date so quickly/ printers don't work etc.

47.

Not as enthusiastic as I was, since time taken up with admin these days. Also there is less teaching time than there used to be.

48.

Yes in theory - helps student to understand to present information in an alternative format BUT packages are expensive -computers in demand -or sometimes even stolen!

49.

blank

50.

Very optimistic - students love to research and investigate using CD ROM leaving me almost redundant!

Many CD Roms I have seen are just flashy pictures or amusing animations. There is room for more in-depth, informative CD-ROMs with simpler graphics and more text.

51.

Yes -although I can't use them now, I have used them in the past and see how much students enjoy this form of interactive learning. The reasons I can't use them now is because I teach an evening class only and have no idea what packages the school has, and a computing class is run in the computer lab on the same night!

52.

Insufficient computer rooms to book whole class in for occasional use, altho' we are better off than most. No space/no money for computers in labs. All the course I teach are very intensive e.g. 1 yr A level for part-time student so not enough time for non-essentials in class time altho' all are introduced to CD-ROMs in library etc

53.

Optimism and Enthusiastic

As access to computers becomes more widely available to both staff and student, their use and integration into the delivery of the curriculum will be second nature. At the moment it seems very time consuming make all the arrangement to facilitate their use in the lab.

There would appear to be two main drawbacks to use of computer and IT in the Biology curriculum.

1. Resources. the cost of computer and software. Although CD ROMs are becoming more widely available in the library.

2. Time for staff to become familiar, confident and comfortable using this new technology in their teaching.

54.

Yes. New computers being installed (to replace a BBC!!) - foresee an increased usage.

55.

Optimistic that CAL packs for an appropriate level ie degree will become available - at present most appear to be pitched at a lower level

56.

Optimistic but in a limited way. Too time consuming. Some software is very poor and not accurate often. 1 hour is about the limit of the concentration span of most of my students on computers.

They will never take over from a personal approach to teaching but add to lessons - simulations etc.

57.

YES! being very new to teaching and just out of university I am very interested and excited by prospect of using learning packages, to add an extra dimension to teaching/ explore new methods of teaching/learning. Especially important to keep 'lower level' student interested. As for higher level student in science, the more experience gained in wordprocessing/data analysis the better as projects/dissertations are undertaken. My only reservation is the time I have to explore the possibilities computers present to teaching.

58.

Enthusiastic but not necessarily optimistic. I would like to use computers on a regular basis particularly with the interactive programmes - unfortunately there are no CD ROM disc players available for science use. Cost will always be a limiting factor.

59.

No doubt any late 20th C educational institution should be using computers in many ways however a combination of incompetent people controlling purchasing and lack of funds means our only classroom computer in Biology at an F.E. college is a BBC!.....and the mice inside are getting tired.

60.

yes: A further mode of delivery + flexibility
scope for student centred learning activities

61.

Yes, extremely useful at all levels for teaching concepts and incorporating into practical schedules. Data Analysis for Ecology.
Too few available -Only successful with very small groups.

62.

Yes, during the coming academic year, I intend to incorporate use of computers into my teaching in class where time permits. Unfortunately, evening class time is v. limited for students and I would be reluctant to move away from "teacher" input + practical experimental work.

63.

Yes, I am both enthusiastic and optimistic about using computers, which I feel are especially useful in biology/physiology teaching. However, resources are limited at present and science at our institution is relatively new and developing. The introduction of computer packages with biological applications is one of our more pressing aims!

64.

Interested - hope they will be as useful as videos.
Hope they will improve students investigations - see results as they emerge and make modifications.
We hope to be given 4 multimedia computers and packages next term. We will monitor usage and evaluate the experience.

65.

I'm very enthusiastic + would hope to utilise computers more in a teaching situation. However, I am not optimistic for the immediate future due to logistics and finance. Ideally I would want a few systems in the labs rather than have to compete for bookings and share a computer room with other classes - makes interactive teaching and learning strategies difficult.

66.

I am very enthusiastic about using computers to prepare materials for teaching. However I reserve judgement on the use of teaching packages for individual students since I do not know enough about educational software.

67

Very enthusiastic. I am actively developing the use of computers for data capture/analysis and as a resource. I feel that software currently available for science could be much improved.

68.

Not particularly - although they have a place. Resources not really available to obtain the requirements. Many are very time consuming and erratic - Need more exposure to better packages - it is not easy to find out about them. Have tried virtual reality surgery etc at exhibition.

Basic simulations or data logging equipment and better interactive biological testing materials would help

current CD-ROMs that I have seen do not improve on books.

Appendix Five

Script for the First Interview

Before interview:

Explain purpose of research, check through interviewee's meaning of CAL, check they are happy to be tape recorded.

1.

- a) What are the resources like generally in the college? (specify hardware, software and any other if asked)
- b) Who controls what hardware and software gets bought?
- c) If you wanted to use computers as part of one of your teaching sessions, what would you have to do?

2. Do you have any colleagues who are using computers as part of their teaching in a way which you think is effective?

3. What features would biological software have to have in order for you to want to use it in your teaching? (reword: have you seen software which you would like to use).

4.

- a) What do you mean by teaching in the context of your work?
- b) What do you mean by learning?
- c) How would you know if a student had learnt something?
- d) How would the student know if they had learnt something?

After interview:

Would they be prepared to be observed? When etc?

Appendix Six

Second letter to survey respondents with software details

3rd July 1996

Many thanks for replying to the questionnaire I sent out in March and for agreeing to be involved in the second stage of the study. This should start in October, but I wanted to contact you before the summer holidays just to let you know what it involves. There are two parts to this second stage:

- a) I'd like to talk to you (for about 45 minutes) about your computing resources in the College and about your general approach to teaching
- b) I'd also like to ask you to look through some software and tell me whether it could be useful to you and how you might use it in the classroom or laboratory.

I have enclosed a list of the software I can provide. For this study I need feedback on any three of the programs listed; or if you prefer, feedback on any two of the programs listed, plus feedback on an additional piece of software which you currently use and like. You are also very welcome to have a look through any of the others which appeal to you. I can bring along a portable Apple Mac machine with the first five programs on, but may need to use equipment you have on site if you want to look at the PC compatible programs or the CD-ROMs (a portable PC compatible machine is currently winging its way to my department at the OU, but its arrival date depends upon convoluted budgets - usual story!).

I hope you are still happy to be involved in this (and maybe even the third stage of the study, which involves observations) and will phone you in October to arrange a suitable date for meeting up. Alternatively, if you have to be in the College over the summer and would prefer to meet up then (any time from the beginning of August) then I'd be very happy to do that instead. Please phone me either on the above number, or on 0973 692409 to leave a message.

Many thanks again

Jane Barnard

A. Apple Mac Programs - (as described by the program developers)

- 1. Plant Stacks** Animation and graphics introduce vegetative anatomy, cell structure, osmosis, plant life cycles and 12 other topics. Some modules include self-quizzes. A test bank offers more than 1100 questions, making lesson planning faster and easier.
- 2. Darwin's Voyage of the Beagle** This simulation allows the student to follow and investigate Darwin's exact voyage while travelling in his vessel, the H.M.S. Beagle. Specific topics of study include climates, people, events, geology, and Darwin's ideas. The program contains extensive quotes from Darwin, giving the student a detailed portrait of both the man and his thinking processes. An excellent preparatory tool for the study of Darwin's Origin of Species, it also demonstrates the scientific method in action.
- 3. MacFrog Academic** Teach your students about five vertebrate frog systems with this pre-lab tutorial. With MacFrog, the student carries out the dissections on-screen, receives full descriptions of each part, and is immediately quizzed on the material just covered. Systems dissected are the mouth, digestive, circulatory, reproductive and skeletal. A final, comprehensive test is included after the lab is completed.
- 4. Mitosis and Meiosis** A helpful supplement for the study of cell division, this animation replicates the living processes of mitosis and meiosis. The student can stop the action to compare the respective stages. An introductory section explains why cell division is important, how it is accomplished in organisms with a nucleus, and how mitosis, meiosis and cytokinesis differ from each other.
- 5. A Tutorial in Recombinant DNA technology** The NCRIPTAL award-winning HyperCard tutorial explores current opinion, conjecture and the potential implications of DNA technology. It includes a biology refresher to help students review such basic cell processes as DNA replication and RNA transcription.

* I will also have **StatView 4**, an integrated statistics, graphics and report writing package, in the next few months.

B. PC Compatible Programs - (as described by the program developers)

1. Biology Simulations The four programs on this disk are designed to allow students to plan investigations; to record, display and interpret data; and to experience practical experimental situations which are otherwise too sensitive or time-consuming to be available in schools. *Plant Mineral Requirements* allows the student to supply plants with various combinations of mineral ions, following which various quantitative comparisons can be made to a control plant. *Metabolism* allows the metabolic rate of four different animals to be studied over a range of temperatures. *Quadrat Sampling in Ecology* illustrates how, by varying the size and number of random quadrats, approximations to the density of organisms in the wild may be achieved, and the distribution pattern of those organisms may be deduced. *Population Genetics* allows the student to discover the changes in gene frequency in a population when factors such as (a) population size (b) strength of selection, and (c) dominance are varied.

2. SimEarth Inspired by James Lovelock's Gaia hypothesis, SimEarth simulates the Earth as a single living organism. You can take charge of an entire planet from its birth until its death - 10 billion years later; guide life from its inception as single-celled microbes to a civilisation that can send rockets to the stars. A variety of graphs and information windows reveal every detail of your planet. You can rule an infinite number of worlds; take over existing planets, or create new, randomly generated worlds. Control your planet's Geosphere, Atmosphere, Biosphere and Civilisations; place life-forms on the land and in the seas; put various levels of civilisation where you want them..... Multiple maps track everything from continental drift to biological diversity. Close-up views (for inspecting and modifying planets) display climate, life, and data layers.

3. Teacher's A-level Biology Student Assessment Based on the same material as the *Student's A-Level Biology Personal Revision* program (which incorporates 18 tests, with questions selected from a large database of classified A-Level standard questions), except that the tests are composed of a fixed list of questions - so that the scores of individual students can be compared. The questions are presented in a randomised order and the answers are given at the end of the test, when students also get a topic by topic breakdown of their scores and an overall mark.

C. CD-ROMs (for PC - as described by the manufacturers)

1. The Ultimate Human Body What happens when you sleep? How does your heart beat? Take an interactive journey inside the human body to discover what every part of the body is called, where it is situated, what it looks like, and how it functions.

2. How Animals Move *How Animals Move* is the most comprehensive and authoritative reference of animals in motion. Written and edited by world authority Professor Neil Alexander in easy to understand language, it is richly supported by video from the BBC's Natural History film library. Eleven guided tours take you on a flying, swimming, jumping, burrowing and crawling journey through the animal kingdom. Sixteen interactive games and experiments are included on the disk to help you deepen your understanding and enjoyment of nature.

3. Images of Biology This CD-ROM is designed to accompany the latest edition of the Toole and Toole book "Understanding Biology for Advanced Level".

4. Biodiversity Contains material developed in Biology departments of British Universities under the Teaching and Learning in Technology Programme (TLTP). Covers material such as Bio-Systematics, Origins and Classification of Life, Cells and Immunity, Worlds and Ecosystems, General Biology and Utilities.

Appendix Seven

Follow-up questionnaire

1. At the time of the survey you were using CAL as part of your biology "n/a". Has this (please tick)

Stayed the same?.... Increased? ☒ Decreased?....

If there has been a change, is there an identifiable reason for this? Realised
that it has been possible to use comp. in class
and wider range of software available.

Are you using different types of applications more? (e.g. internet) yes

2. Have you had any further training for IT use over the last two years? no

If so, in which particular areas?

3. At the time of the interview your general resourcing was "four 486s in room between labs"

Has this changed much? It has not changed. Although they

If so, how? are partly maintained and software
is dated.

4. Do you feel that any of your managers (e.g. Head of Departments, Curriculum Managers, Staff Development Managers, Principals) are particularly keen and supportive about use of learning technologies? They would say so, I think not.

If so, how? (e.g. arranging training, supplying resources etc)

Has this changed much over the past two years?

Any other comments?

Session made me think about how to
use computers educationally. Thankyou.

Sorry I never got back to you
re second session.

Best regards

Appendix Eight

Letter from Donald McIntyre (1998)

School of Education

Head of School: Professor Donald McIntyre MA MEd
Secretary of the School: Gillian Morley MA



UNIVERSITY OF
CAMBRIDGE

29 December, 1998

Ms Jane Barnard
Institute of Educational Technology
The Open University
Walton Hall
Milton Keynes
MK7 6AA

Dear Jane

Thank you for sending me your very interesting paper. I am sorry that there was not an opportunity to talk in Belfast and also that it has not been until now that I have had a chance to read the paper.

Your use of the framework developed by Sally and me to try to understand better the problems of classroom innovation, and especially and crucially the continued low usage of CAL, is imaginative and of course exciting for me. I do believe that it is highly plausible that the effort necessary for an experienced teacher to replace an established NDS by a new one is likely to be considerable and therefore likely to be made only if the prize to be gained is for some reason a substantial one. I imagine (stimulated by your accounts) that there could both be a need for difficult mental readjustment as one accepts that the educational value of one's established NDS is less than that of a newly conceived/understood NDS, and also the problems of deskilling and reskilling oneself.

One of the interesting things about your paper, however, is that none of the reported cases seem to be about new *approaches to pedagogy*, or therefore new suggested NDSs, but are rather about new content-related learning experiences which the computers may be able to deliver for the students. This is not then a situation where teachers are being encouraged to replace one NDS by another, but rather one in which teachers need to explore the implications of providing these new learning experiences.

One thing which Sally and I did not tackle were questions about similarity and dissimilarity of NDSs and how one might assess these with some objectivity. Your own accounts of similarities are very persuasive, but you might want to think about how you could resist any challenge to claims of this kind. Another related thing which we didn't think about was the idea that each teacher has characteristic kinds of NDS. I'm not sure how necessary such an idea is to your argument, but it certainly is there when, for example, you talk about 'Pam's typical NDS'. As yet, however, I don't think that we have clear evidence to support the idea, apart from your own. I suppose that unless one relies on some such idea, it would be difficult to know whether one had identified exhaustively all the relevant NDSs in a teacher's repertoire; and that becomes especially difficult if one can't spend a lot of time observing that teacher. Talking with the teachers about their range of practices might be a possibility, but it would mean depending heavily on their self-awareness.


I like your general thesis that teachers will, where possible, modify attractive new materials in order to assimilate them to their existing preferred ways of students working ; but that 'larger applications' of CAL do not lend themselves to this. I wonder too whether there's a general corollary, that when the use of new materials or applications cannot be assimilated to established NDSs, there will be no NDS available for the teacher to rely on, so that success has to be judged in other (Progress ?) terms. I confess that I find the last four of your cases difficult to get my head round, although you certainly seem to be right about the elements of novelty/unusualness, technical complexity, relative lack of consideration of student conditions and the emphasis on Progress. Am I right that it is also in these four actions ? It seems almost as if they are technicians, health and safety officers, managers, etc., anything except teachers taking responsibility for their students' learning (processes or outcomes).

I hope you are submitting your paper for publication in something very close to its present form; but even more, I hope that you will pursue this research, without necessarily changing anything about it, with further cases. It does seem to me that you have raised some fascinating questions and hypotheses which need further exploration.

Finally, I am intrigued by Jim. Don't underestimate his importance. I hope you will find some way of publishing a fuller account of him.

Very best wishes

Yours sincerely



Donald I McIntyre